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# THE JOURNAL

OF

## THE LINNEAN SOCIETY.

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On certain Points in the Morphology of the Cystidea.  
By P. HERBERT CARPENTER, D.Sc., F.R.S., F.L.S., Assistant  
Master at Eton College.

[Read 15th January, 1891.]

(PLATE I.)

### 1. THE BODY PLATES.

IN many Cystideans the plates enclosing the dorsal part of the body are as regularly arranged as in the cup of a Crinoid, and various comparisons have been drawn between the two. Gottsche\*, for example, has endeavoured to find a correspondence between the calyx of *Hemicosmites* and that of *Actinocrinus*, which has a hexagonal base consisting of three equal plates. The supposed base of *Hemicosmites* is also hexagonal, but is composed of four plates, two large and two small (Pl. I. fig. 1; *ib.* 1-4). Gottsche supposes that the suture between the two larger ones indicates the position of the anal interradius, and he describes the cup as consisting of "4 B, 5 R', 3 R" (schmal, rechteckig), 5 IR', von denen eines direct mit der Basis articulirt, und 2 IR'' über diesem unpaaren IR'."

One great objection to this analysis is that the supposed azygos

\* Sitz.-Ber. Ges. Nat. Freunde Berlin, 1886, p. 13.

IR' obviously belongs to the second cycle of plates (Pl. I. fig. 1. 8), while the two IR'' resting upon it (15, 16) are members of the third cycle, the other four plates of which Gottsche also calls IR' (11, 12, 14, 17). Alternating with them are the three plates which Gottsche calls second radials (A, 13, 18). It appears to me, however, that the symmetry of *Hemicosmites* is hexamerous, and not pentamerous, as Gottsche and others have supposed; and I also believe the base to be dicyclic. The four plates of the proximal series, called basals by Hall\* and Gottsche, are infrabasals (Pl. I. fig. 1; *ib.* 1-4), two of them being double plates, just as in the pentamerous *Codiocrinus*, *Hypocrinus*, and *Sagenocrinus*. The tripartite monocyclic base of *Platycrinus* and the Blastoids is an analogous case. The six plates of the second cycle (5-10), Hall's subradials, which alternate in position with those of the first, are the basals (*b*). This basal ring supports a series of nine plates, six of which (*r*) alternate with the basals, and are, I believe, the radials; while the other three (A, 13, 18) which rest upon the three anterior basals are interradianals (*i*). *Caryocrinus* (Pl. I. fig. 2) has only two of these (13, 18), the median anterior one being unrepresented in that type. But in other respects the lower part of its cup is entirely similar to that of *Hemicosmites*, and its hexamerous symmetry is even more strongly marked. This is well shown by the fact that each of the two large infrabasals (2, 3) is marked by two double rows of hydrospire-pores, which terminate respectively at the distal angles of the plate, just as the median row on each of the two smaller infrabasals terminates at its distal angle. There are thus six double rows of pores, and at the distal angle of every infrabasal the double row gives rise to two other rows, one upon each of the basals which rest upon it. It is true that these six basals (5-10) are not all of the same shape or size; but I do not see how any one can doubt that they are all morphologically equivalent, and belong to the same cycle of plates. Von Buch laid great stress upon this point†:—

“Hier ist keine Spur, keine Andeutung, welche auf eine Zertheilung zu Fünf hinführen könnte. Alles wird, bis zu den geringsten Kleinigkeiten, von der

---

\* “Descriptions of some new Fossils from the Niagara Group,” Twentieth Annual Report New York State Cabinet of Natural History. Albany, 1867, p. 315.

† Ueber Cystideen.” Abhandl. d. k. Akad. d. Wiss. Berlin, 1844, p. 99.

Zahl Sechs bestimmt und beherrscht, eine Zahl, welche sich auf keine Weise mit Fünf vereinigen lässt. Der Kelchboden besteht aus vier ungleich grossen Asseln, welche, wie vorher gezeigt worden ist, sich ohne Mühe zu sechs ganz gleichen und ähnlichen Asseln zerlegen lassen. Sechs Seitenasseln, sechs Schulterblätter, bilden den Kelch, und sechs Arme erheben sich auf seinem Rande, drei doppelte nämlich und drei einfache. Das alles ist den übrigen Crinoideen ganz fremd."

Hall \*, in 1852, referred to the four basals, six costals, six scapulars, and two interscapular plates of *Caryocrinus*; while Roemer † described the cup as dicyclic, with four basals, six parasbasals, six radials, and two interradians, or, as we should now say, four infrabasals and six basals. It is therefore not a little surprising that Gottsche should have endeavoured to reduce the symmetry of *Caryocrinus* to that of a pentamerous type like *Actinocrinus*, from which Von Buch had so carefully distinguished it.

Few recent writers, however, seem to have understood that the cup of *Caryocrinus* is hexamerous with a dicyclic base, followed by radials, though both facts are clearly explained by Quenstedt ‡. Zittel §, for example, calls the four unequal plates which rest upon the stem the basals; but his nomenclature goes no further, though his account of the number of plates in the dorsal cup is correct enough. Steinmann || also says that "Zum basalen Kranz gehören 4 Platten," which are followed by a second row of six, alternating with the plates of the first and third cycles. But then he goes on to say "Der dritte Kranz setzt sich ebenfalls aus 6, etwas niedrigeren Tafeln zusammen." He here omits all notice of the two plates which are intercalated within the ring of radials, each resting on the truncated end of a large anterolateral basal (Pl. I. fig. 2; 13, 18). The appendages of the adjacent radials encroach more or less upon these plates, which were called interscapulars by Hall, and may perhaps now be considered as true interradians, corresponding to the similarly situated plates in *Thaumatocrinus* and *Rhodocrinus*.

These eighteen plates of *Caryocrinus* reappear, plate for plate, in Von Koenen's two genera, *Corylocrinus* and *Juglandocrinus*,

\* 'Palæontology of New York,' vol. ii. 1852, p. 216.

† 'Lethæa Geognostica,' Bd. i. Theil 2, 1852-54, p. 269.

‡ 'Petrefactenkunde Deutschlands,' Bd. iv. 1876, 1874-76, p. 662.

§ 'Handbuch der Palæontologie,' Bd. i. 1876-80, p. 418.

|| 'Elemente der Paläontologie,' 1888, p. 183.

from the Caradoc beds of Montpellier. They are both dicyclic and hexamerous, though this is not the way in which Von Koenen interprets their structure\*. The two genera resemble one another and differ from *Caryocrinus* in the absence of any appendages on the third cycle of plates, or radials. In *Caryocrinus* the upper edges of these plates meet the peripheral plates of the vault, the construction of which will be considered later. But in *Hemicosmites* there are no appendages round the margin of the calyx, which contains another cycle of plates above the radials. Müller † has given a good description and figure of the six plates which bound the peristome and support the three ambulacra proceeding from it (fig. I. on p. 22). I believe that these plates reappear in *Juglandocrinus* (fig. III.), a point to which we shall return.

*Caryocystis granatum*, as described by Von Buch ‡, also has a proximal series of two large and two small plates, which I regard as infrabasals. Above these come in succession three alternating series of six plates each, basals, radials, and interradians (in the widest sense of the term), and above these again are other plates, somewhat irregularly disposed, which are probably mere indifferent body-plates.

Gottsche's interpretation of this type is a curious one §. He regards the base as monocyclic, and five of the six plates in the next ring as R', the odd one being an interradian, just as in *Hemicosmites*. Above these he places five second radials, altogether overlooking the fact that R'' do not alternate with R' in any Crinoid, so that any comparison which assumes this must be altogether devoid of a morphological basis; and it is curious that the very distinct hexamerous symmetry of this type should have so entirely escaped Gottsche's notice. The form which is figured in Angelin's 'Iconographia' || under the name of *Caryocystis testudinaria* is pentamerous, while *C. alutacea*, Angelin, and *C. prominens*, Angelin, seem to be tetramerous. In like manner some forms of *Protocrinus oviformis* are distinctly dicyclic and hexamerous, while others are more irregular and indicate a divergence

\* "Ueber neue Cystideen aus den Caradoc-Schichten der Gegend von Montpellier," Neues Jahrb. f. Min. 1886, Bd. ii. pp. 249-254.

† "Ueber den Bau der Echinodermen," Abhandl. d. k. Akad. d. Wiss. Berlin, 1853, Taf. vi. fig. 5.

‡ *Loc. cit.* pp. 17, 18, Taf. ii. fig. 4.

§ *Loc. cit.* p. 13.

|| 'Iconographia Crinoideorum,' 1878, tab. xiii. fig. 8.



towards such types as *Megacystis* and *Echinosphæra*, in which it is difficult to trace any definite symmetry, though certain individuals appear to have a hexamerous base; and the peristome of *Echinosphæra aurantium* may have two, three, or four ambulacral extensions, thus foreshadowing the variations of *Actinometra*. It may be noted, however, that Hall mentions a single species of Crinoid from the Hamilton group with a hexamerous base\*. Four Cystidean genera, at any rate, *Caryocrinus*, *Corylocrinus*, *Hemicosmites*, and *Juglandocrinus*, are typically hexamerous, a point which is not without interest from its bearing on the general question of the morphology and phylogeny of the Echinoderms.

Many pentamerous Cystids resemble the types above mentioned in having a dicyclic base. Thus in *Echinoencrinus* (Pl. I. figs. 3, 4) the so-called basals, plates 1-4 of Forbes's nomenclature †, are really infrabasals, plate 3 being a double plate. Alternating with these are the subovarian series (Nos. 5-9) or first parabasals of Volborth ‡, which are the true basals; while the second parabasals or centrolaterals, Forbes (Nos. 10-14), are, I believe, the radials. The lower part of the body is constructed upon this plan in all the following genera:—*Apiocystis*, *Callocystis* (Pl. I. fig. 5), *Cystoblastus* (fig. 7), *Glyptocystis* (fig. 8), *Lepadocrinus* (fig. 6), *Pleurocystis*, *Prunocystis*, *Pseudocrinus*, and probably also in *Sphærocystis* and *Strobilocystis*; and although in some cases, e. g. *Echinoencrinus*, the radial character of these second parabasals is not apparent at first sight, yet in types like *Pseudocrinus* and *Apiocystis* they are traversed by some of the ambulacra, while in *Cystoblastus* (Pl. I. fig. 7) they are deeply incised by the latter, and are transformed into regular fork-pieces, like the radials of the Blastoids, as already noticed by Volborth §. The resemblance of all these types to one another is such that if plates 10-14 of *Cystoblastus* be admitted as radials (and this, I think, will scarcely be denied) the same name must be extended to the centrolaterals or second parabasals of all the

\* 'Palæontology of New York,' vol. ii. p. 223.

† "On the Cystideæ of the Silurian Rocks of the British Islands," Mem. Geol. Survey Great Brit. 1848, vol. ii. part 2, p. 487.

‡ "Ueber die Arme der bisher zu den armlosen Crinoiden gezählten Echinoencrinen," Bull. Class. Phys.-Math. Acad. Imp. Sci. St. Pétersbourg, 1844, tome iii. No. 6, p. 2 (of separate copy).

§ "Ueber Achradoecystites und Cystoblastus, zwei neue Crinoideen-Gattungen," Mém. Acad. Imp. Sci. St. Pétersbourg, 1870, tome xvi. no. 2, p. 12.

remaining genera. It will then be convenient for descriptive purposes to denote the five radials by the letters A-E, as I have done in the case of the Crinoids\* and Blastoids, taking the anterior radius as A, and those to the right and left of the anus as C and D respectively†. The infrabasals, being radially situated, may then be denoted by the corresponding small letters, plates *c* and *d* being those which, in all the above-mentioned genera, are fused into the large double plate 3 (Pl. I. figs. 3-8).

Above and alternating with the radials of *Echinoencrinus* are the five plates of the fourth cycle (15-19), which Forbes called supra-ovarian, and Volborth radial axillaries. I have endeavoured to show, however, that the plates in *Echinoencrinus* which really represent the radials of other Echinoderms are the centrolaterals or second parabasals of Volborth; and these, together with the two series of plates in the dicyclic base, make up the complete dorsal cup, such as we find in many Asterids, Ophiurids, and Crinoids. But it is not easy to assign any definite homologies to the fourth series of plates in the Cystidean calyx, even supposing that they are always identical in character. In *Hemicosmites* (fig. I.) two of them are distinctly radial, and one is interrarial, while the other three have no definite position. They sometimes alternate very regularly with the radials, as in *Echinoencrinus* (Pl. I. figs. 3, 4), and so would almost seem to be interradians. In certain genera one of them is missing, and not always the same one, as I shall show immediately. But even in *Echinoencrinus* there are indications of their being in relation with the divisions of the lobate peristome, and in the somewhat irregular calyx of *Glyptocystis* (Pl. I. fig. 8) each of them supports an ambulacrum, a point to which I shall return.

All the three Russian species of *Echinoencrinus*‡ have two pore-rhombs in the base of the cup, which are situated on plates

\* "On the Genus *Actinometra*, Müll., with a Morphological Account of a new Species from the Philippine Islands," Trans. Linn. Soc., Zool., 1879, vol. ii. p. 26.

† The lettering used above follows the course of the coiled gut of a Crinoid, as seen from the ventral side, and it thus goes in the reverse direction to Forbes's numbering of the Cystidean plates, as seen from the dorsal side.

‡ I have not attempted to go into the complicated question of the synonymy of this genus, but have simply made use of the names employed by Volborth in his memoir "Ueber die Echinoencrinen" (Bull. Acad. Imp. Sci. St. Pétersbourg, 1842, tome x. p. 293).

1-5 and 1-6 respectively (Pl. I. fig. 4). *E. granatum* has three other rhombs in the higher parts of the cup, while in *E. striatus* and *E. angulosus* there is but one, on plates 14-15 (Pl. I. fig. 4). This, together with that on plates 1-5, reappears in the two British species, and a third rhomb, on plates 12-18, is often present (Pl. I. fig. 3). All the species of *Pseudocrinus* have rhombs on plates 1-5 and 14-15; while in the two bifasciate species (*P. bifasciatus* and *P. magnificus*) the third or left-hand rhomb is on plates 13-17\*, its lower half being on radial D (13) instead of on radial E (12), as in *Echinoencrinus armatus* (Pl. I. fig. 3). I believe, however, that it occupies the latter position in the two quadrifasciate species, as it also does in *Apiocystis*, but the fact is not mentioned by Forbes. His figures of the two bifasciate species show that they have but four supra-ovarian plates, that of interradius AB (No. 16) being absent. It is present, however, in the other two species, or at any rate in *P. quadrifasciatus*; while in none of the specific descriptions is there any reference to a 19th plate in the cup. But in the generic diagnosis five supra-ovarian plates are described†, thus raising the total to nineteen, viz., 4, 5, 5, 5.

We meet with a similar difficulty in the case of *Apiocystis*. On p. 501 it is stated that the number and arrangement of the plates is the same as in *Pseudocrinus*. But there is no mention of any plate 19, and upon p. 502 the supra-ovarian series is described as consisting of four plates only, though five are mentioned in the generic diagnosis on p. 503. At any rate, if one be missing it is not that of the interradius AB (No. 16), which would normally rest on radials 10 and 11, and is absent in the bifasciate species of *Pseudocrinus*; for this plate is well shown in Forbes's figures 1 and 6, as also in *Pseudocrinus quadrifasciatus*. The two interradians of the left side (17, 18) are certainly present, as also the second one on the right (15), but it is not easy to make out from Forbes's figures, or indeed from the specimens, whether one is present on the anal side. According to his descriptions *Apiocystis* resembles *Echinoencrinus angulatus* in having rhombs on plates 1-5 and 14-15, and he mentions a third on plates 13-18 of the left side. I believe, however, that 13 is here a misprint

\* In Forbes's diagram of *P. magnificus* the two halves of this rhomb are stated to be on plates 13-18. The latter is obviously a misprint for 17, as is apparent from the figures of the species on Forbes's plate xii.

† *Loc. cit.* p. 500.

for 12, which is nowhere noticed in Forbes's description of the cup, while he states that 13 is on the postea side; and so far as I can judge from the specimens which I have seen, this is certainly the case.

In Hall's figures of *Apiocystis elegans*\* the plate bearing the lower half of the left-hand rhomb is marked 12, and, I believe, correctly so; but I cannot agree with his interpretation of the higher plates of the cup. Resting on basals 7 and 8, and notched, like them, by the anal opening, is a plate which Hall describes as sometimes simple and sometimes divided into three†. He refers to it as belonging to the third series, and rightly so, I think; but the simple plate is marked 17 in one of his figures, and in the other its three parts are called 17, 18, and 19 respectively, which would seem to imply that it belongs to the fourth or supra-ovarian series. It appears to me, however, that this plate, whether simple or compound, is plate 13 of the centrolateral series, or, as I should call it, radial D. It touches on the left the rhombiferous plate 12, and altogether corresponds to plate 13 in Forbes's figures of *Echinoencrinus*, more especially *E. armatus*, var. (Pl. I. fig. 3). In like manner the rhombiferous plate on the right, which is marked 13 in Hall's figures, is radial C, plate 14 of Forbes's nomenclature, and I would alter the numbering of the remaining plates as follows:—

Hall.		Numbering now proposed.
A, fig. 5.	B, fig. 6.	
17	17, 18, 19	13
13	13	14
19	21	15
14	14	16
15	15	17
16	16	18
18	20	19

\* 'Palæontology of New York,' vol. ii. pl. li. figs. 5, 6.

† *Ibid.* p. 242.

A similar correction should, I believe, be made in the description of *Lepadocrinus*, as given by Hall\*. He states that there are four plates in the first and five in the second series, but only four in the third, Nos. 10, 11, 12, 13, the last two bearing pectinated spaces. Above these come the five supra-ovarian plates, Nos. 14–18. There is no mention of any additional plate, though 19 are shown in his figure †, which I have copied for comparison with that of *Echinoencrinus* (Pl. I. figs. 3, 6). As in the case of *Apiocrinus elegans*, it will, I think, be clear that the supra-ovarian plate which arches over the anus is No. 13, or radial D, while the rhombiferous plate to its right is really 14, and not 13 as believed by Hall. The interradiial plate above this, which bears the other half of its rhomb, would then be 15, and the corresponding one on the left side 18, as I have marked in my copy of Hall's figure (Pl. I. fig. 6).

If this interpretation of the calyx be correct, *Apiocystis elegans* and *Lepadocrinus Gebhardi* resemble both *Echinoencrinus* and one another in having a complete series of five interradials, making a total of nineteen plates, with pore-rhombs on 1–5, 12–18, and 14–15. The two American species have four ambulacra, a point in which they resemble the British *Apiocystis pentremitoides*, with a similar arrangement of pore-rhombs. But it is not clear whether this last type has all five interradials, and the same may be said of the two quadrifasciate species of *Pseudocrinus*. Hall ‡ and Zittel§ have included *Lepadocrinus*, *Pseudocrinus*, and *Apiocystis* under the one generic name *Lepadocrinus*, but it appears to me that the two bifasciate species of *Pseudocrinus* represent a distinct generic type for which Pearce's name should be retained. It is possible that the quadrifasciate species and also *Apiocystis pentremitoides* are congeneric with *A. elegans* and *Lepadocrinus*; but if it should ever be proved that the interradial CD is absent in the former and present in the latter, Forbes's genus might perhaps be retained, and increased by the addition of the two quadrifasciate species of *Pseudocrinus*.

The relations of these three genera would then be somewhat as follows :—

\* 'Palæontology of New York,' vol. iii. p. 127.

† *Ibid.* pl. vii. fig. 23. ‡ *Ibid.* vol. iii. p. 126.

§ 'Palæontologie,' Bd. i. p. 421.

	Left-hand Rhomb.	Ambulacra.	Interradials.	
<i>Pseudocrinus bifasciatus</i> .....	13-17	2	AB missing.	} <i>Pseudocrinus</i> .
„ <i>magnificus</i> .....	13-17	2	AB missing.	
„ <i>quadrifasciatus</i> .....	12-18?	4	CD missing.	} <i>Apiocystis</i> .
„ <i>oblongus</i> .....	12-18?	4	CD missing.	
<i>Apiocystis pentremitoides</i> .....	12-18	4	CD missing.	} <i>Lepadocrinus</i> .
„ <i>elegans</i> .....	12-18	4	All present.	
<i>Lepadocrinus Gebhardi</i> .....	12-18	4	All present.	

N.B.—*Pseudocrinus*, as limited above, is probably a good genus; but I have my doubts as to the separation of *Apiocystis* from *Lepadocrinus*.

Another interesting and geologically earlier form is *Lepocrinites* (*Lepadocrinus*) *Moorei* of Meek\*, from the Cincinnati group of Indiana, which differs from *L. Gebhardi* in having five ambulacra and a pore-rhomb on plates 10-15, in addition to those on 1-5, 12-18, and 14-15. I am inclined to regard these characters as of generic value, and would propose therefore to distinguish Meek's species by the name *Lepadocystis*.

*Callocystis* is another genus presenting the same general plan of structure, though I should not interpret its calyx quite in the same way as Hall† has done. Five of the eight costals which he describes in the second cycle are, I believe, the true basal plates, Nos. 5-9 (Pl. I. fig. 5), those namely which are marked 5, 6, 8, 9, 11 in Hall's figure; while his plates 7, 10, and 12 seem to me to represent radials E, C, and B, or plates 12, 14, and 10 respectively, in *Echinoencrinus* and *Lepadocrinus* (Pl. I. figs. 3, 6). They are situated lower than usual and enter the basal ring, just as the posterior radials do in certain species of *Hemicidaris* and other Urchins. The anal opening would then be situated between basals 7 and 8 below and a single plate above, which I regard as representing radial D or plate 13 of *Echinoencrinus* and *Lepadocrinus* (Pl. I. figs. 3, 5, 6). This being the case, the pore-rhombs of *Callocystis* occupy the same positions as those of the above-mentioned types, viz., on plates 1-5, 12-18, and 14-15, though its five ambulacra and the peculiar relations of its radials give it a very distinct generic position.

\* Rep. Geol. Surv. Ohio, Palæontology, vol. i. 1873, p. 39, pl. iii. fig. 4.

† 'Palæontology of New York,' vol. ii. p. 238, pl. 1.

White\* has described a Devonian genus, *Strobilocystis*, in which "the principal plates are probably similar to those of *Callocystis*." It has three pairs of rhombs, but only four ambulacra. Its generic position must, therefore, remain uncertain till the composition of its calyx can be definitely ascertained.

We have seen that in the bifasciate *Pseudocrinus* the interradial AB is undeveloped, while in *Apiocystis* that of CD is perhaps wanting. *Cystoblastus* is distinguished by the absence of any plate in interradius DE, the suture between these radials being continued right up to the peristome, just as in many Blastoids (Pl. I. fig. 7). This type is further remarkable for the entry of the other four interradians into the radial ring, two of them (17, 18) appearing in the figure. In fact, No. 18 forms the right-hand margin of the anal aperture, and cuts plate 14 off from it altogether. It may be noted too that in *Cystoblastus*, as in the Russian species of *Echinoencrinus* (Pl. I. fig. 4), there is a pore-rhomb on plates 1-6 in addition to that on 1-5, as Volborth† and Schmidt‡ have already pointed out.

Another remarkable form with the same two basal rhombs and largely developed interradians (?) is the *Glyptocystis multipora* of Billings§ (Pl. I. fig. 8). Plates 16 and 17 are both of unusual size, the former coming down to rest on basal 5, so as to separate radials 10 and 11, which last is a small plate, just as in *Callocystis* (fig. 5); while No. 12 is also much reduced, and plate 7 is altogether to the left of the anus, which is bounded by basal 8 and radials 13, 14, as it would be in *Cystoblastus*, but for the low position of interradius 18 (Pl. I. fig. 7). On the other hand, in the Russian *Glyptocystis pennigera*, the anal opening is greatly extended at the expense of two basals (7, 8) and three radials (12, 13, 14), and was covered, according to Schmidt||, by a delicate plated integument. From such a form as this the transition is

\* "Descriptions of New Fossils from Palæozoic Rocks of Iowa," Proc. Acad. Nat. Sci. Philad. 1876, p. 28.

† Mém. Acad. Sci. St. Pétersbourg, 1870, tome xvi. no. 2, p. 12.

‡ "Ueber einige neue und wenig bekannte Baltisch-Silurische Petrefacten," *ibid.* 1874, tome xxi. no. 11, p. 10.

§ "On the Cystideæ of the Lower Silurian Rocks of Canada," Figures and Descriptions of Canadian Organic Remains, decade iii. 1858, p. 54, pl. iii.

|| *Loc. cit.* p. 18, tab. i. figs. 7 d, 10. [N.B.—Schmidt's numbering goes from right to left across the page; while that of Forbes, which I have followed, goes from left to right. If Schmidt's figures be altered in accordance with this plan, basal 9, beneath the anus, becomes basal 7, as I have implied above.]

easy to *Pleurocystis*, Billings, in which basals 7 and 8 and radial 13 seem to be altogether lost in the integument of small plates covering the anal side. Compare, for example, figs. 1 *a* and 1 *c* on plate i., or figs. 1 *a* and 1 *b* on plate ii. of Billings's memoir\*, with figs. 7 *a* and 7 *d* on Schmidt's tab. i. On the other hand, the numerous pore-rhombs of *Glyptocystis* are reduced to three in *Pleurocystis*, which are situated respectively on plates 1-5, 13-14, and 11-12, the first of which is, as we have seen, common to all this group of Cystids.

There is one point about *Glyptocystis* which cannot be left without notice, and I must confess that it has puzzled me a good deal, viz., the relations of the ambulacra to the calyx-plates. In the case of *Cystoblastus* (Pl. I. fig. 7) the five plates which a morphological study of the abactinal pole indicates as the radials also stand in direct relation to the ambulacra, so that there can be no possible doubt about their homology. *Apiocystis* and *Lepadocrinus* have but four ambulacra, which sometimes extend down on to the basals, as in *Hybocystis*, and two or more of the radials are traversed by the ambulacra, the relations of which to plates 10 and 11 (radials A and B) are well seen in Hall's figures of *Apiocystis elegans*† and *Lepadocrinus Gebhardi*‡. But in *Glyptocystis multipora*, with its somewhat irregular calyx, this is much less evident (Pl. I. fig. 8). Plates 12, 13, and 14 are all traversed by ambulacra; but that corresponding to plate 10 is too short to reach it, while the remaining one lies altogether to the left of plate 11, and passes at once from plate 16 on to the basal below it. On the other hand, the five plates (15-19) which lie above the radials of this type, alternating with some of them, and resting directly upon others, seem to coincide in position with the ambulacra (Pl. I. fig. 8). This is still more marked in the Russian species, *G. pennigera*, and especially in *G. sculpta* and *G. gigantea*§, in which the fourth series of plates have almost the same relation to the ambulacra as those of the aberrant Blastoid *Cryptoschisma*. A somewhat similar condition appears in *Lepadocystis Moorei*, and under these circumstances it is not easy to assign any definite homologies to these plates of the fourth series in the Cystidean calyx. They are occasionally

\* *Loc. cit.*

† 'Palæontology of New York,' vol. ii. pl. li. figs. 1-4.

‡ *Ibid.* vol. iii. pl. vii. figs. 2, 4.

§ Mém. Acad. Imp. Sci. St. Pétersbourg, 1874, tome xxi. no. 11, tab. ii. figs. 9, 11.



altogether absent, as in *Hybocystis*, and although apparently interradian in position in some types, they seem in others to be definitely related to the ambulacra. They would probably be best considered as perisomic plates, without any distinct orientation; and in some forms they are succeeded by others of the same character. Such, for example, are the small plates round the peristome of *Cryptocrinus* and *Apiocystis elegans*, and the larger ones of *Glyptocystis pennigera*; while in many Cystideans the whole body is made up of these irregularly arranged perisomic plates, just as in the Psolidæ among the Holothurians, and all traces of a calyx comparable to that of a Crinoid have disappeared.

Under the name of *Caryocystis pumila*, Eichwald\* has figured a curious form with the body covered by four, or perhaps five, alternating series of plates. The anus is low down, notching two of the plates of the second series, which I take to be the basals, just as in *Hemicosmites*, *Echinoencrinus*, and their allies (Pl. I. figs. 1-6). In the rare genus *Prunocystis*† from Dudley there are at least three regular alternating series of plates, which correspond respectively to the infrabasals, basals, and radials of *Echinoencrinus*. The same is the case in *Macrocystella*‡, Callaway, of Tremadoc age, and also in another member of the Primordial fauna, *Lichenoides*, Barrande§. Two others of Barrande's genera, *Mimocystis* and *Homocystis*, present similar characters||, and would seem, indeed, to belong to the same group as *Echinoencrinus*, as already suggested by Barrande, but they are not sufficiently well preserved for this to be made out with certainty.

Enough has been said, however, to show that there are a considerable number of Cystids which are characterized by the possession of a dicyclic calyx like that of a Crinoid, and that these may be grouped round two central forms, *Caryocrinus*, with hexamerous symmetry, and *Echinoencrinus*, which is penta-

\* 'Lethæa Rossica,' 1860, vol. i. sect. 1, p. 629, pl. xxxii. fig. 19 b.

† Mem. Geol. Survey, vol. ii. pt. 2, pl. xvi.

‡ "On a new Area of Upper Cambrian Rocks in South Shropshire, with a Description of a new Fauna," Quart. Journ. Geol. Soc. 1877, vol. xxxiii. p. 669, pl. xxiv. fig. 13.

§ 'Système Silurien du Centre de la Bohême,' vol. vii. 1887, Cystidées, p. 183, pl. i.

|| *Ibid.* pp. 77, 160, 164, pl. xxviii.

merous, with the two infrabasals of the anal side (CD) united into one large plate. *Echinoencrinus* and *Caryocrinus* are taken by Steinmann\* as the types of his group Cystocrinoidea, while *Lepadocrinus*, which he unites with *Pseudocrinus*, is placed with *Glyptosphaera* and *Echinosphaera* among the Eucystoidea, in which there are "keine deutlichen freien Arme, dagegen meist Ambulacralfurchen oder -felder entwickelt." Steinmann does not state his views respecting *Callocystis* and *Apiocystis*; but I cannot see that their appendages, or those of *Lepadocrinus* and *Pseudocrinus*, are in any way so markedly different from those of *Echinoencrinus* as to justify a separation of this kind. The ambulacra of *Echinoencrinus* are very short, and hardly extend beyond the peristome, so that the appendages are limited to its immediate neighbourhood, forming what Steinmann calls "freie Arme an der Grenze der Ober- und Unterseite." But *Lepadocystis Moorei* and *Lepadocrinus Gebhardi*, together with *Apiocystis* and *Callocystis*, afford a complete transition to the condition of *Pseudocrinus*; and considering the resemblance in the composition of their dorsal cups, I should include all these genera in the Cystocrinoidea, leaving the more irregular forms with numerous plates as the Eucystoidea.

We have seen that one of the infrabasals in the pentamerous *Echinoencrinus*-group is a double plate (Pl. I. figs. 3-8; 3), and that there are two such plates in the hexamerous *Caryocrinus* and its allies (Pl. I. figs. 1, 2). This is also the case in the pentamerous *Hypocrinus* and *Cryptocrinus*. In both types, so far as I can make out from the published figures of them, the single infrabasal is that of the right anterior ray (B), those of radii AE and CD being respectively fused (Pl. I. fig. 9).

*Hypocrinus*† is certainly a very singular form, and one would like to know more about it. The three infrabasals are followed by five equal and similar basals, and these again by five radials which are described by Beyrich as bearing "die Ansatzstellen der Arme." The anal opening is placed at the top of one of the basals, also notching the lower angles of the two radials which rest upon it, a condition which recalls that of *Gasterocomma* among the Crinoids. *Glyptocystis multipora* presents a similar peculiarity (Pl. I. fig. 8), and the same would be the case in *Cystoblastus*

\* *Op. cit.* p. 182.

† See Beyrich, "Ueber eine Kohlenkalk-Fauna von Timor," Abhandl. d. k. Akad. d. Wiss. Berlin, 1864, p. 83, Taf. ii. fig. 16.

(Pl. I. fig. 7), but for the intercalation of an interrarial plate (18) within the radial ring. Beyrich was inclined to refer *Hypocrinus* to the Cystids, chiefly, it would seem, on account of this character, and his example has been very generally followed. But it is altogether unlike the other Carboniferous Cystids, and I cannot help suspecting that it is really a Crinoid, allied to *Lecythiocrinus*, White\*. The type-specimen of this genus, which was found in the Upper Coal Measures of Kansas, has three infrabasals, two of which are double plates, just as in *Hypocrinus*; and above these are five basals and five radials, the latter being bent inwards, somewhat as in *Hypocrinus*, and bearing small facets for the arms. In this species, *L. olliculæformis*, there is no trace of an anal aperture in the dorsal cup, and it would seem, therefore, to have been situated in the disk above. But in the unique *L. Adamsi*, Worthen†, from the lower Coal Measures of Illinois, which has five infrabasals, there is a circular opening between the summit of one basal and the lower angles of the two radials above it. Worthen described this as filled with stony matter, and left it an open question whether it is "an anal opening or an accidental break in the test of the body." The analogy of *Hypocrinus* would seem to indicate that this is an anal opening, and that *L. Adamsi* should be referred to this genus and not placed with *L. olliculæformis*, in which the anus does not open within the dorsal cup. The latter is also the case in the Devonian genus *Codiocrinus*, Schultze, which likewise has three infrabasals, five basals, and five radials, all in contact; and except in the characters of the arm-facets, there is no structural difference between *Lecythiocrinus*, as defined by White, and Schultze's type. Wachsmuth and Springer have noticed this resemblance‡; but they say nothing about Worthen's remark as to the possibility of the anus piercing the dorsal cup of *L. Adamsi*. Should this really be the case, this species can hardly be referred to White's genus; while, except in the number of infrabasals, it would much resemble *Hypocrinus*, to which Wachsmuth and Springer make no reference in the text of the 'Revision,' though the name appears in the index. They might have known

\* "Descriptions of New Species of Carboniferous Invertebrate Fossils," Proc. U.S. Nat. Mus. 1880, vol. ii. p. 256, pl. i. figs. 4, 5.

† Geol. Survey of Illinois, vol. vii. 1883, p. 317, pl. xxx. fig. 8.

‡ "Revision of the Palæocrinoidea.—Part III. Sect. 2," Proc. Acad. Nat. Sci. Philad. 1886, p. 152.

that Beyrich's genus is figured in the atlas to Quenstedt's Encriniden, though the type is described in the text as a Cystid\*. S. A. Miller† has proposed to replace *Lecythiocrinus*, White, by *Menocrinus*, on the ground that the former name is pre-occupied by *Lecythocrinus* of Müller and Zittel. But the two names are not identical; and even if they were, there is some doubt as to the validity of Müller's genus, so that there is no need for the introduction of *Menocrinus*. Miller‡ notices the difference between the two American species in the number of infrabasals, though he persists in calling them basals, and he regards it, if really existing, as of generic value; but he appears never to have heard of *Codiocrinus* and *Hypocrinus*. The similarity of the plates in the dorsal cup in the latter type to those of *Codiocrinus* and *Lecythiocrinus* seems to me to indicate clearly that it is a Crinoid and not a Cystid. The same view has been taken by Bather§.

*Cryptocrinus* is also a very puzzling form (Pl. I. fig. 9). I have endeavoured to reconstruct the calyx of *C. cerasus* from Von Buch's projection ||, which does not seem to be altogether in accordance with his description or other figures. He supposed that one of the five plates (*Seitenasseln*) which rest upon the three infrabasals was divided horizontally into two parts, which I have marked respectively 7 and 13. The five plates above these (*Scheitelasseln*, Von Buch) would then come to be radials. His projection shows an additional plate between 9 and 10, which is not at all clear in his two views of the cup from above and the side. I have indicated it in fig. 9 by a dotted line, and have marked it *x*. It would seem to belong to the peristomial series rather than to that of the dorsal cup, and may be left out of consideration for the present. I am inclined to think, however, that plate 13 is not the upper half of a divided basal, as supposed by Von Buch, but that it should rather be regarded as radial D, which has been displaced downwards and a little to the side, so as to rest directly on basal 7, and underlie radials 12 and 14 (E and C). The analysis of the calyx of *Cryptocrinus lævis* which

\* *Op. cit.* p. 687, tab. 113. fig. 94.

† 'North American Geology and Palæontology,' 1889, p. 262.

‡ "The Structure, Classification, and Arrangement of American Palæozoic Crinoids into Families," Amer. Geologist, 1890, vol. vi. p. 351.

§ "British Fossil Crinoids, II.," Ann. & Mag. Nat. Hist. 1890, vol. v. p. 382.

|| *Loc. cit.* Taf. ii. fig. 5.

appears in Angelin's 'Iconographia' \* may be interpreted in the same way, and the small peristomial plates which appear to belong to the ambulacral skeleton are well seen in his figures of the summit †. One of the latter also shows the low pyramid of five oral plates, one of which is considerably larger than its fellows. The large one, however, is not that of the anal interradius (CD) as in *Sphæronis*, but that of the next one (DE), in which the so-called genital opening is placed.

In the preceding pages I have endeavoured to show that many Cystideans have a calycular system which is essentially similar to that of the Crinoids, and I cannot, therefore, agree with Lovén ‡ when he says:—"In the Cystoidea—in which every trace of a calyx is wanting, at least in the adult—the basal part of the skeleton is formed by the perisome alone." This seems to me to be far too general a statement, though it is no doubt applicable to *Sphæronis*, *Glyptosphæra*, and similar forms. But I can scarcely imagine that Lovén will deny the presence of a calyx in such forms as *Cystoblastus* (Pl. I. fig. 7), or even in *Caryocrinus* (fig. 2), though he appears to believe this to be the case in *Callocystis* (fig. 5).

## 2. THE SUMMIT OPENINGS.

Most palæontologists now believe that the mouth of a Cystid was placed at the point of convergence of the ambulacra, as is the case in all the other Echinoderms, and the anal function of the lateral valvular opening has been generally acknowledged for some time past, as may be seen in any standard text-book of zoology and palæontology, though Sturtz § has recently suggested that it may represent the madreporic opening of Starfishes. Under these circumstances it is not a little unfortunate that the whole question should again have been thrown into confusion by S. A. Miller, whose utterances on the subject of Cystids in his recent volume on North American Geology and Palæontology are vague in the extreme. He admits that the mouth of a Blastoid was situated at the point of convergence of the ambulacra, and that the lateral opening was the anus. In his diagnoses of *Glytocystis* and *Gomphocystis*, however, he calls the latter the

\* *Op. cit.* tab. xii. fig. 2.

† *Ibid.* figs. 3–5.

‡ "On *Pourtalesia*, a Genus of Echinoidea," K. Svensk. Vetensk. Akad. Handl. 1883, Bd. xix. No. 7, p. 10.

§ "Neuer Beitrag zur Kenntniss palæozoischer Seesterne," Palæontographica, Bd. xxxvi. 1890, p. 242.

mouth and the former the ambulacral opening, though he never explains the meaning of this term. His descriptions of *Agelacrinus* and *Apiocystis* contain no reference to the mouth at all; but the lateral valvular opening, which is called the mouth in *Glyptocystis*, is noticed as ovarian in *Apiocystis*, and as ovarian or anal in *Agelacrinus*, while in the case of *Caryocrinus* it is spoken of as "the mouth or anal orifice"\*. From Miller's descriptions of *Callocystis*, *Hemicosmites*, and *Sphærocystis*, it may perhaps be inferred by a "scientist" that he believes the mouth of these types to be situated at the ambulacral centre. But the average amateur or student, for whom the book is also published, could hardly be expected to discover this fact from such statements as "oral, ovarian, and anal apertures," or "mouth apical; opening subapical; ovarian opening on the summit"†.

No educated palæontologist would now admit the possibility of such extraordinary departures from the general type of Echinoderm structure as Miller's descriptions involve; and few, if any, will now deny that the position of the mouth of a Cystid coincides with that of the ambulacral centre, as was so ably argued by the late Sir Wyville Thomson‡ in 1861, and subsequently by Lütken§ and A. Agassiz||. In some genera there is evidence of its having been concealed beneath a covering of oral plates, as in so many Palæocrinoids. These are well preserved in *Cyathocystis Plautinæ*, Schmidt¶, and are tolerably equal in size, as in *Stephanocrinus*. But in various species of *Sphæronis* as figured by Angelin, in *Glyptosphæra Leuchtenbergi* (Pl. I. fig. 15), and in *Pyrocystis desiderata*, Barrande (Pl. I. fig. 11), the posterior oral is larger than its fellows, as in *Haplocrinus* and in so many Camerata\*\*.

\* *Op. cit.* p. 231.

† *Ibid.* pp. 230, 282.

‡ "On a new Palæozoic Group of Echinodermata," Edinburgh New Philosophical Journal, 1861, vol. xiii. p. 112.

§ "Endnu et Par Ord om de gamle Söliliers 'Snabel' og Mund," Vid. Med. Naturhisk. Forening i Kjöbenhavn for 1869, Nr. 9-13, pp. 185-188.

|| "Note on Lovén's Article on *Leskia mirabilis*, Gray," Annals Lyc. Nat. Hist. 1869, vol. ix. pp. 242-245.

¶ "Ueber *Cyathocystis Plautinæ*, eine neue Cystideenform aus Reval," Verh. russ. kais. min. Gesellsch. St. Petersburg, 1880, ser. 2, vol. xv. pp. 1-7.

\*\* I take this opportunity of cordially acknowledging the generous manner in which Messrs. Wachsmuth and Springer have recently admitted the truth of the view which I have advocated persistently since 1879, respecting the homology of the four anterior proximals of the Palæocrinoidæ with the orals of the Neocrinoidæ. They were steadily opposed to it from the first, but have at last assented to it (Proc. Acad. Nat. Sci. Philad. 1888, p. 348); and now that they

A still closer approach to the condition of the Actinoecrinidæ is presented by *Caryocrinus* (Pl. I. fig. 14). The greater part of the summit is occupied by six oral plates, together with two smaller ones, which bound the anal opening. Immediately in front of this is a heptagonal or hexagonal plate, round which the five others are grouped symmetrically. I have seen one specimen in which this plate is nearly pentagonal; and the two antero-lateral orals meet above it, pushing the anterior one away with it, so that the summit looks very much like that of an ordinary pentamerous form. The normal arrangement of these summit-plates in *Caryocrinus* at once recalls the five orals of the Camerata, viz., a central plate in front of the anus, with four others round it, the so-called proximals. But why are there five proximals in *Caryocrinus*? Simply because the symmetry of this type is hexamerous and not pentamerous. Wachsmuth and Springer must have overlooked this well-known fact when they stated that the eight plates round the central piece of *Caryocrinus* "are arranged in a totally different manner from the so-called proximals of the Palæocrinoidea"\*. The anterior and the postero-lateral orals coincide in position with the primary ambulacra, of which there are only three, and they are therefore considered as radial in position by Wachsmuth and Springer, who remark:—"We think the distribution and arrangement of the surrounding plates in *Caryocrinus* prove conclusively that these cannot be orals, for the most ingenious speculator would be unable to reconstruct

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have discovered for themselves that the supposed central plate is really the displaced posterior oral, which is not represented by two small plates separated by the anus, as we formerly supposed, my comparison of it to the dorsocentral of the abactinal system need not be further considered. It is proper for me to state, however, that some months before Messrs. Wachsmuth and Springer's change of opinion had been made public, Professor Beyrich had convinced me, during a visit to Berlin at Easter, 1888, that the supposed central plate in the summit of the Camerata is really the posterior oral homologous with that of *Haplocrinus*. He had then held this view for some time, and it had been suggested as a possible one by Wachsmuth and Springer in 1885. But it was never seriously advocated by them; and even as late as 1887 they criticized me somewhat severely for still believing in the oral nature of the summit-plates in *Allagecrinus*, *Coccocrinus*, *Culicocrinus*, &c., and of the four anterior proximals in the Camerata generally. These criticisms, however, were altogether withdrawn in the following year, and we are now in complete accordance upon this long-discussed question.

\* "The Summit-Plates in Blastoids, Crinoids, and Cystids, and their Morphological Relations," Proc. Acad. Nat. Sci. Philad. 1887 p. 100.

five primitive plates from such an assemblage of pieces as we find in *Caryocrinus* and in Von Koenen's new genus *Juglandocrinus*. What those plates may be, whether actinal or abactinal structures, we will not pretend to decide; but we do undertake to say that they are not orals, otherwise the rule that there are always five primitive orals meets with a very serious exception"\*. I am not aware of the absolute rule to which they refer, for where there are six basals, a point which Wachsmuth and Springer have overlooked, one would certainly expect to find six orals. They have also forgotten the fact that, besides the ordinary pentamerous form of *Rhizocrinus*, Sars † described individuals with 4, 6, and 7 rays, and a corresponding number of "valvules orales."

In this same communication, published in 1887, before their change of opinion, Wachsmuth and Springer say "*Caryocrinus* has a large central piece, and this is surrounded usually by eight plates, which are arranged in a totally different manner from the so-called proximals of the Palæocrinoidea. Three of them are radial, the others are interrarial. The interrarial pieces alternate with the radial ones, one to each side, except at the anal inter-radius, where three smaller pieces take the place of the single one at the two other sides." At that time the American authors regarded the central piece as a composite oral plate, like that of the Camerata; but they have since recognized that the latter is really the posterior oral displaced forwards‡, and that the smaller plates between it and the anus are not members of the proximal series at all, but anal plates. On the same principle *Caryocrinus* would have to be regarded as having six orals, a central one and five others round it (fig. II., and Pl. I. fig. 14). But Wachsmuth and Springer have given no hint that they now take this view of its structure, and I conclude, therefore, that they regard the summit of *Caryocrinus* as composed of three orals, a central and two antero-laterals, with three alternating radial plates which cover the ambulacra. This would mean, of course, that the actinal plates of *Caryocrinus* are trimerous and not hexamerous, as those of the dorsal cup are; and the fact that three of them cover the primary ambulacra seems, at first sight, to be a strong

\* *Ibid.* p. 107.

† 'Mémoires pour servir à la Connaissance des Crinoïdes vivants,' Christiania, 1863, pp. 18, 19.

‡ "Discovery of the Ventral Structure of *Taxocrinus* and *Haplocrinus*, and consequent modifications in the Classification of the Crinoidea," Proc. Acad. Nat. Sci. Philad. 1888, pp. 342, 348.



argument in favour of this view. But the number of the ambulacra in a Crinoid or Cystid is not a satisfactory test for determining the primary symmetry of the type. A similar condition to that of the hexamerous *Caryocrinus* with three primary ambulacra is presented by the ten-rayed *Promachocrinus*, the disk of which has only five primary ambulacra. In *Actinometra*, which has a pentamerous calyx, the number of ambulacra joining the peristome may vary from three to ten, and those of the posterior rays do not by any means coincide in position with the radial plates of the dorsal side. In *Echinosphæra aurantium* there may be two, three, or four ambulacra \*. *Pseudocrinus* has but two, though its dorsal cup is pentamerous, and the latter is also the case in *Sphærocystis*, *Apiocystis*, or *Lepadocrinus*, which have but four primary ambulacra. The hexamerous *Hemicosmites* has a triradiate peristomial area, while *Juglandocrinus*, also hexamerous, has three pairs of ambulacral openings; the symmetry of the ambulacra thus indicated is in each case the same as in *Caryocrinus* (figs. I.—III.). Wachsmuth and Springer have pointed out how in the latter genus the three primary ambulacra coincide in position with three of the six summit-plates, the anterior and the two postero-lateral ones. I have indicated the course of these subtegminal ambulacra in a figure of the summit, which shows the interradian position of the six orals (*o*), as determined by the symmetry of the dorsal cup (fig. II.). Since there are only three primary ambulacra which supply three pairs of radials (11–12, 14–15, 16–17), it is obvious that they would naturally occupy interradian positions and so come to lie beneath three of the orals, which were not movable like those of Neocrinoids, but formed part of a rigid tegmen. This is well shown in fig. II. (See Postscript, *infra*, p. 51.)

In *Juglandocrinus* the ambulacra are subtegminal, but Von Koenen's description † shows clearly that there must be three primary trunks, each opening externally by two pores on the edges of the plates which he marks *m* (fig. III.). Von Koenen says in reference to these openings:—

“Sehr eigenthümlich sind bei unserer Art die sechs paarig angeordneten Löcher im Scheitel. Falls sie nicht, wie bei den Palæocrinoiden, auf Arm-Ansätze zu deuten sind, was bei ihrer Lage wenig wahrscheinlich ist, würde eine

\* See Volborth, “Ueber die russischen Sphaeroniten,” Verh. min. Ges. St. Petersburg, 1845–46, p. 18 (of separate copy), and Taf. ix, figs. 6–8.

† *Loc. cit.* p. 253.

Fig. I.

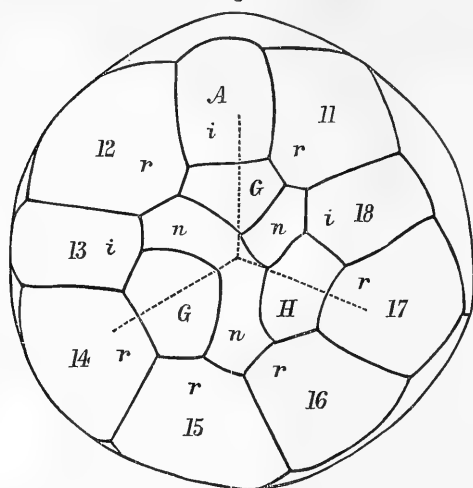


Diagram of the summit of *Hemicosmites pyriformis*. The course of the ambulacra, which are superficial, is indicated by dotted lines.—*r* (11, 12, 14–17), radial plates; *A*, the anterior interradial; *i* (13, 18), anterolateral interradials; *G*, *H*, *n*, peristomial plates (orals?). Copied from Müller (Abhandl. Berlin Akad. 1853, Taf. vi. fig. 5).

Fig. II.

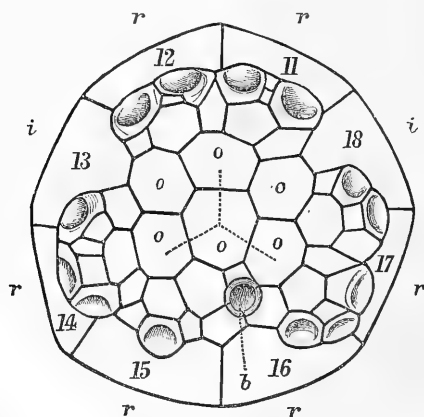
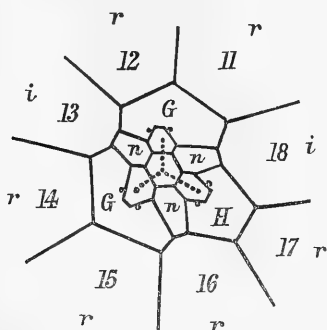


Diagram of the summit of *Caryocrinus ornatus*, showing the relation of the orals (*o*) to the plates of the dorsal cup (11–18), which are lettered as in Fig. I.—*b*, anus. The dotted lines indicate the course of the subtegmental ambulacra. From Mr. Wachsmuth's specimen, represented in Plate I. fig. 14.

sehr auffällige Analogie mit den paarigen Oeffnungen oder vielmehr Kanälen im Scheitel der Blastoideen ins Auge zu fassen sein. Sie müssen aber auch zum Theil die Funktionen von Mund und After erfüllt haben."

It seems to me that there can be little doubt as to the ambulacral nature of these six openings in the summit of *Juglandocrinus*. They were not related to hydrospires, as Von Koenen seems to

Fig. III.



Summit of *Juglandocrinus crassus*. Copied from Von Koenen (N. Jahrb. f. Mineralogie &c. 1886, Bd. ii. Taf. ix. fig. 3). The dotted lines indicate the course of the subtegmina, which opened externally by three pairs of pores. (N.B. One of these pairs has been accidentally omitted in Von Koenen's original figure, in which the three superambulacral plates are marked *m*).—Plates 11–18, radials and interradials of the dorsal cup as in Figs. I., II.; G, H, *n*, peristomial plates (orals?).

suggest; but the food-particles entered through them on their way to the central mouth, just as they did at the arm-openings of the Palæocrinoidea. If the comparisons drawn above between the ambulacra of *Juglandocrinus* and those of *Caryocrinus* and *Hemicosmites* be in any way valid, then the anus of the former type should be looked for somewhere in the neighbourhood of plates 15 and 16. It would also seem to follow that the central plate and the three super-ambulacral orals of *Caryocrinus* correspond respectively to the central plate and the three plates *m* of *Juglandocrinus*. I have some doubt\*, however, as to whether

\* One possible view would be to regard the two anterior plates, *n*, which rest upon the two interradials 13, 18, as representing the anterolateral orals of *Caryocrinus*, and the posterior plate *n* as an anal summit-plate. But if the central plate could be disestablished, as that of *Haplocrinus* was, there would then be but six plates (orals?) in the summit, just as in *Hemicosmites* (fig. I.).

the two remaining orals of *Caryocrinus* are represented in the latter type (fig. III.), which seems to occupy a curiously intermediate position between *Caryocrinus* and *Hemicosmites*. Alternating with the three plates *m* are three others, situated interradially or nearly so, which are marked *n* in Von Koenen's figure; and outside these again, in the direction of the ambulacra, are three larger plates, two of which, G, G, are interradiial, while the third, H, rests directly on the top of radial 17. These six plates are well shown in the summit of *Hemicosmites*, as figured by Müller \*, and I have lettered them accordingly in my copy of his figure (fig. I.). Two points, however, are noteworthy. *Hemicosmites* has an anterior interradiial, A, between radials 11 and 12, which is not represented in *Caryocrinus* or *Juglandocrinus*; and the anterior summit-plate, G, thus rests directly upon it instead of on the suture between the two radials. In the second place, the ambulacra of *Hemicosmites* are external. There is a triradiate peristome in the centre of the summit which extends outwards as grooves on to the surface of plates G, G, H, the whole structure being roofed in by smaller plates, which are probably ambulacral covering-plates, very much as in *Cyathocrinus*.

The close agreement between the varying conditions of the oral plates in different Cystidean genera and those of the later Crinoids is very remarkable. We have already traced the resemblance between the summit of *Caryocrinus* and that of an Actinocrinoid. The five orals of *Cyathocystis*, with their distal angles abutting on the ambulacral skeleton of each ray, reappear under similar conditions in the young *Platycrinus symmetricus*, recently figured by Wachsmuth and Springer †. So far as can be judged from the condition of the fossils, the orals were movable in *Cryptocrinus*, *Sphaeronis*, and *Glyptosphaera* (Pl. I. fig. 15), which were the fore-runners of the recent *Hyocrinus*, *Rhizocrinus*, and *Thaumatocrinus*. Lastly, in *Ascocystis* the orals, if ever developed, must have disappeared as completely as in a recent *Pentacrinus* or *Comatula*. Barrande seems to have been somewhat puzzled by the condition of the ventral surface with its five reniform compartments ‡, and believed "que l'ouverture était rameuse et composée d'arcs entourant les compartiments réniformes, d'une manière comparable à celle que nous voyons dans divers autres genres de Cystidées,

\* Abhandl. d. k. Akad. d. Wiss. Berlin, 1853, Taf. vi. figs. 4, 5.

† Proc. Acad. Nat. Sci. Philad. 1888, pl. xviii. fig. 15.

‡ *Op. cit.* p. 117, pl. xxxiii. fig. 13.

comme *Echinoencrinus Senkenbergi*, Von Buch." It is obvious, however, that these ramifying lines indicate the positions of the ambulacra diverging from a central peristome, and that the five compartments which they enclose represent the five interambulacral areas on the disk of a Neocrinoid, the larger one being that of the anal interradius. It was probably pierced by the rectum, as in the recent forms, and the whole disk of *Ascocystis*, with its ambulacra dividing to supply the numerous appendages round its edge, bears a singular resemblance to that of a *Metacrinus* such as *M. nobilis* \* and *M. rotundus* †, in which the pinnule-ambulacra appear on the disk. In the Pentacrinidæ, too, the peristome and the bases of the ambulacra are roofed in by covering-plates without any distinct traces of orals, just as in many Cystids.

The presence of an oral pyramid consisting of five plates in the form which Barrande called *Pyrocystis desiderata* ‡ is a point of some importance, as it conclusively settles the nature of the structures which he called "hydrophores palmés." They are well shown in his figure of the interior of the test of this type (Pl. I. fig. 10); while that of the exterior shows their relation to the oral plates, which suggests at once that they are subtegminial ambulacra. This obvious explanation of them has already been given by Neumayr on quite different grounds §; but it did not find favour with the anonymous reviewer of Barrande's work in 'Nature,' who criticised it as follows || :—

"Neumayr thinks that the opening which they surround is the mouth, and that they are subtegminial ambulacral grooves. How this can be when their distal ends are unconnected with the exterior is not easy to understand. Barrande, moreover, cannot say whether they are at the oral or aboral pole. A comparison of figs. 28 and 32 on pl. xxix. suggests that they are at the aboral end, and that the large opening represents the axial canal of the stem. May they not be connected with nerve-cords passing from a chambered organ?"

The reviewer is no doubt right in assuming that the large opening seen in fig. 28 is the axial canal of the stem; but there is not much resemblance between this and the low quinquepartite pyramid of fig. 32 on the same plate, which, as shown in fig. 33

\* Zool. Chall. Exp., "Report on the Crinoidea," vol. xi. 1885, pl. xliii. fig. 3.

† Trans. Linn. Soc. 1884, ser. 2, Zool. vol. ii. pl. 1. fig. 2.

‡ *Op. cit.* pl. xxix. figs. 32, 33.

§ 'Die Stämme des Thierreiches,' Bd. i. 1889, p. 409.

|| 'Nature,' vol. xl. 1889, p. 269.

(Pl. I. figs. 10, 11), covers the point of convergence of the hydrophores. This covering, however, is closely similar to what is universally recognized as the oral pyramid of *Glyptosphæra Leuchtenbergi* (Pl. I. fig. 15), a point which the reviewer must surely have forgotten, or he would scarcely have put forward the suggestion contained in the paragraph quoted above. It is singular, too, that he should not have been struck by the resemblance between the grouping of the hydrospires round a central pentagonal space and the ambulacra diverging from the angles of the low oral pyramid in *Glyptosphæra* (Pl. I. fig. 15) or in *Sphæronis*, as shown in figures 18 and 20 on pl. xi. of Angelin's 'Iconographia.' It is also somewhat remarkable that neither Barrande nor his reviewer should have noticed the resemblance of the "hydrophores" in *Pyrocystis* to the ambulacra of *Proteocystis*, which are figured and rightly interpreted on the next plate of Barrande's monograph. A glance at this ought to have dispelled all the reviewer's doubts as to the "hydrophores" belonging to the oral pole.

Barrande would also seem to have forgotten the closure of the mouth by oral plates in *Sphæronis*, *Glyptosphæra*, and *Cyathocystis*, or he would scarcely have written of it as follows\*:—"Cette ouverture n'est accompagnée d'aucun appareil destiné à la fermer. Nous devons donc concevoir qu'elle était constamment ouverte." On the following page he adopted Von Buch's opinion that the large lateral opening is genital in function and the small one near it anal; and yet the 'Nature' reviewer says that "the accepted views are confirmed by Barrande." He also compared the fourth and slit-like aperture close to the mouth of *Aristocystis* (Pl. I. figs. 12, 13, *d*) to the peculiar folded structure described by Volborth† in *Glyptosphæra Leuchtenbergi* (Pl. I. fig. 15, *d*); and the 'Nature' reviewer adds:—"More closely still does it resemble the 'reniform groove' or 'semilunar pore' figured by Forbes in the fossils which he called *Apiocystis* and *Echinoëncrinus*." The same idea had also occurred to myself, and I have been led to conclude that there are a large number of Cystids in which an opening like that of the water-pore of recent Echinoderms is represented, and that it occupies a position close to the peristome in or near the interradius CD.

\* *Op. cit.* p. 43.

† 'Ueber die russischen Sphaeroniten,' p. 29, pl. x. fig. 1.

The fourth opening of *Aristocystis* (*d*) is situated immediately behind the elongated peristome, generally towards its left end; though sometimes it is a little nearer the centre (Pl. I. figs. 12, 13). The position of the third or genital opening (*c*), however, seems to vary considerably in this type as depicted in Barrande's figures. It is sometimes on the very edge of the anal opening (*b*), as shown in fig. 12, while in other individuals it is nearly halfway towards the peristome (fig. 13), as in *Protocrinus oviformis*. The former condition obviously suggests that in other Cystids, in which no third opening has been discovered, the genital ducts and rectum may have opened together into the space beneath the valvular pyramid, through which they would have had a common outlet to the exterior, analogous to the "anal spiracle" of the Blastoids. Volborth\*, de Verneuil†, and Roemer‡ long ago suggested this as a possible explanation of the function of this structure, and we now know of a precisely similar case among certain Starfishes.

In the members of the family Pterasteridæ there is a sort of marsupial pouch on the dorsal surface of the disk, into which the oviducts and the anus both open, and it communicates with the exterior by an opening which Sladen has termed the oscular orifice. In the genera *Hymenaster* and *Pythonaster* this opening is guarded by five fan-like valves§, each composed of a number of spines united by perisome; but while in *Hymenaster* the marsupium or nidamental cavity covers the entire disk, owing to the great development of the supradorsal membrane, it seems to be reduced in *Pythonaster* to the small space within the oscular valves. Many Cystids were probably in this condition, *i. e.* with a valvular osculum common to the oviducts and rectum—*e. g.*, *Agelacrinus*, *Amygdalocystis*, *Comarocystis*, *Caryocrinus*, *Hemicosmites*, *Malocystis*; though it is of course possible that they may have had a separate genital opening which has not yet been discovered. In eleven of the twenty-one genera in which the third opening has been described, whether as the anus or as the genital pore, it is situated behind the mouth in the same interradius as

\* Bull. Acad. Imp. Sci. St. Pétersbourg, 1842, tome x. p. 295.

† 'Géologie de la Russie d'Europe et des Montagnes de l'Oural,' par Murchison, de Verneuil, et Keyserling: Londres et Paris, 1845, vol. ii. p. 27.

‡ 'Lethæa Geognostica,' Bd. i. p. 263.

§ Zool. Chall. Exp., "Report on the Asteroidea," vol. xxx. 1889, p. 469, pl. lxxxiv. figs. 1, 3, pl. xcv. fig. 1.

the osculum, or nearly so\*. This is well shown in *Aristocystis* (Pl. I. figs. 12, 13) and *Glyptosphæra* (fig. 15), both of which, and perhaps also *Pyrocystis* (figs. 10, 11), had a fourth opening (*d*) in the same interradius, which must, I think, be regarded as excretory in function.

The small second opening (*c*) in the anal interradius CD has been generally considered, of late years, as a genital pore; but the condition of *Aristocystis* shows the probability of its fusion with the anus (Pl. I. figs. 12, 13). Hence in *Echinoencrinus* and its six allies † (which have no second opening in the anal interradius) the oviducts and rectum may have had a common oscular opening, as supposed for *Agelacrinus* and *Caryocrinus*. But if so, what was the third opening, that in interradius DE, of these types? If genital, its position outside the anal interradius is somewhat anomalous; and I cannot help suspecting that it may be an excretory pore. The researches of the Sarasins seem to indicate that the problematical ovoid gland of *Asthenosoma* is really a kidney which opens externally through the madreporite ‡; and they point out that Prouho's description of the ovoid gland and its connections in *Dorocidaris* § is capable of a similar interpretation; though Cuénot's studies of the Asterids and Ophiurids have led him to regard this organ as essentially a lymphatic gland which produces the amœboocytes of the cœlom and vascular system ||. Kowalevsky ¶, on the other hand, concludes from his experiments that it is an excretory organ; and I am inclined to think that there is much to be said for this view of its function,

\* *Aristocystis*, *Caryocystis*, *Deutocystis*, *Echinosphæra*, *Glyptosphæra*, *Megacystis*, *Orocystis*, *Proteocystis*, *Pyrocystis*, *Protoecrinus*, *Sphæronis*. This third opening is possibly also present in *Allocystis*, Miller, and *Trochocystis*, Barrande, though its position is not easy to determine from the published figures of these types. That of *Eucystis* seems to be in interradius BC.

† *Apiocystis*, *Callocystis*, *Cystoblastus*, *Cryptocrinus*, *Echinoencrinus*, *Glyptocystis*, *Sphærocystis*, and possibly *Lepadocrinus*.

‡ "Ueber die Anatomie der Echinothuriden und die Phylogenie der Echinodermen," *Ergebnisse Nat. Forsch. Ceylon*, 1888, Bd. i. Heft 3, pp. 105-114.

§ "Recherches sur le *Dorocidaris papillata*, et quelques autres Échinides de la Méditerranée," *Arch. de Zool. Exp. et Gén.* 2<sup>e</sup> sér. vol. v. 1888, pp. 114-119 (of separate copy).

|| "Études anatomiques et morphologiques sur les Ophiures," *ibid.* vol. vi. 1888, pp. 50, 66. See postscript, *infra*, p. 45.

¶ "Ein Beitrag zur Kenntnis der Excretionsorgane (Schluss)," *Biol. Centralbl.* 1889, Bd. ix. pp. 73, 74.



which does not necessarily exclude that advanced by Cuénot. So far as the Crinoids are concerned, it seems to me not unlikely that the structure at the ventral end of the ovoid gland, which I have described as the labial plexus \*, or at any rate the specially modified portion of it which forms the spongy organ, may be nephridial in function. It is most largely developed round the hinder part of the peristome, between it and the anus; while the inner ends of some of the water-pores open in close proximity to it, and may even be in connection with it, as described by Perrier †.

Wachsmuth and Springer have recently suggested that the apparently poriferous plate between the mouth and anus of *Cyathocrinus* is a madreporite ‡, and their view is supported by the fact of this being the primary position of the water-pore in the larval Echinoderm.

Under these circumstances there is much reason to think that Volborth § was right in suggesting that the plicated triangular structure between the mouth and genital pore of *Glyptosphaera Leuchtenbergi* may be a madreporic plate. Quenstedt || says that it seems to consist "aus drei welligen Klappen, . . . und niemals fehlt." It is well shown in the two figures of the Russian species in Angelin's 'Iconographia' ¶, and is explained by Lovén as the "rhombus"; but there is no indication of it in Zittel's figure of the same type \*\*, nor is it mentioned in his generic description. Steinmann †† figures it, however, and compares it to a madreporite. Barrande ‡‡ compared it, and I think rightly so, to the slit-like opening just behind the peristome of *Aristocystis* (Pl. I. figs. 12, 13); while the 'Nature' reviewer extended the comparison to the opening at the edge of the peristome, just above plate 18, in the British *Echinoencrinus*, which Forbes had regarded as the anus §§. There would seem, however, to be something wrong about Forbes's description of this opening as being on the right

\* 'Report upon the Crinoidea of the 'Challenger' Expedition,' 1885, p. 98.

† 'Mémoire sur l'Organisation et le Développement de la Comatule de la Méditerranée,' 3<sup>me</sup> Partie, Nouv. Arch. du Muséum, 3<sup>e</sup> série, t. ii. (Paris, 1890) p. 69.

‡ "The Perisomic Plates of the Crinoids," Proc. Acad. Nat. Sci. Philad. (1890) p. 358, pl. ix. fig. 7.

§ 'Ueber die russischen Sphaeroniten,' p. 29, Taf. x. fig. 1.

|| 'Encriniden,' p. 694.

¶ *Op. cit.* tab. xi. figs. 1, 2.

\*\* 'Paleontologie,' Bd. i. p. 416.

†† *Op. cit.* p. 178.

‡‡ *Op. cit.* p. 45.

§§ *Loc. cit.* p. 485, pl. xviii. fig. 3.

side, above plate 15; for his figures of *E. armatus* on pls. xviii. and xix. show that it is on the left side above plate 18, *i. e.* in interradius DE. He assigned a similar position to the anus or "reniform groove" of *Apiocystis pentremitoides*; but Hall\* was "unable to observe the reniform groove or pore on the right side near the apex" of *A. elegans*, while he found one, or possibly two, on the left side above the plate which he marked 16, though I should call it 18, as I have already pointed out. Hall took these to be the mouth and anus. But what he called the "single straight groove in the direction of the back and front of the body" is now known to be the linear peristome containing the mouth; and should the second opening described by him really exist, we must, I think, regard it as excretory, while the other, if present, may be genital. The same remark applies to *Callocystis*, in which the peristomial plates of interradius DE are pierced, according to Hall†, by the mouth and anal pore, and also bear a little porous tubercle which "strongly reminds one of the madreporiform tubercle in *Asterias* and other Echinoderms."

Further information about these structures is much to be desired, and it is quite possible that the "porous tubercle" of *Callocystis* may be of the same doubtful nature as the similarly-named structure which Hall described a few pages further on in *Hemicystis*, though later writers have made no allusion to it. Another of Hall's genera, *Sphærocystis*‡, has a small opening close to the peristome in the same interradius DE. It also occurs in *Glyptocystis multipora*, as described and figured by Billings§, while Lovén marked it as the genital aperture in Angelin's figure of the summit of *Cryptocrinus lævis*||.

I am inclined to think that in all these genera with no separate genital opening in interradius CD, which seems to be its normal position, there was a common osculum for the anus and genital ducts, as in *Hymenaster*; while the lateral opening in interradius DE was excretory in function. Indeed, one might almost say that it represented a madreporite, and also placed the water-vascular system in communication with the exterior. The presence of this aperture in the same position in seven of those genera which have a pentamerous and dicyclic dorsal cup like that

\* 'Palæontology of New York,' vol. ii. p. 243, pl. li. figs. 7, 8.

† *Ibid.* pp. 238, 240.

‡ 'Palæontology of New York,' vol. iii. p. 130, pl. vii. A, figs. 1-5.

§ *Loc. cit.* p. 56, pl. iii. fig. 1 *g.*

|| *Op. cit.* tab. xii. fig. 3.

of a Crinoid is a point of some interest, and may prove to be of use for purposes of classification. I would likewise assign an excretory function to Volborth's organ in *Glyptosphaera* and the fourth opening in *Aristocystis* (Pl. I. figs. 12, 13, 15), and it is quite possible that Volborth was correct in regarding the former as a madreporite. At any rate it occupies the same position, relatively to the genital pore, the mouth, and the anus, as the madreporic opening has in those Holothurians in which it retains its primitive connection with the exterior; and we must not lose sight of the possibility that there may have been Cystids which had a distinct external madreporic opening in early life, though it subsequently closed up, as is the case in many Holothurians.

Thus, for example, it may have remained permanently open in *Glyptosphaera* and have closed in *Protocrinus*, the nephridial duct, if such existed, perhaps acquiring a communication with the exterior through a genital pore. I do not wish to be understood as implying that I fully believe this to be the case. But in endeavouring to throw some light upon the morphology of these ancient forms, one must not lose sight of the possibilities of explanation afforded by their recent representatives.

The analogy of *Glyptosphaera* and *Aristocystis* would seem to indicate that when there is a distinct opening *between* the mouth and anus, as in *Sphaeronis*, *Protocrinus*, and *Proteocystis*, it should be recognized as genital; though we might, of course, look upon it as excretory, and assume that there was a common oscular orifice for the anus and genital ducts, as I have done for *Agelacrinus* and *Caryocrinus*. I must confess that I am rather inclined to take this view of *Sphaeronis*\*, which has a large anal pyramid just behind the mouth, and a minute valvular opening close to the left posterior ambulacrum (D) which may very well have been excretory in function. It is quite possible also that the third opening of *Caryocystis*, *Echinosphaera*, and *Megacystis* was nephridial or madreporic, rather than genital†, though it might, of course, have served both functions, as suggested above. This possibility is to some extent supported by the embryological fact that the primary water-pore of Echinoderm larvæ is situated in the anal interradius, which also contains the chief part of the labial plexus and ovoid gland of a Crinoid,

\* See Angelin's 'Iconographia,' tab. xi.

† See postscript, *infra*, pp. 49, 50.

*i. e.* the supposed kidney. On similar grounds, too, we might regard the lateral pyramid of *Agelacrinus* as the common oscular orifice of the nephridial, genital, and digestive systems.

The above argument is based on the supposition that the Cystids had an ovoid gland (kidney, *Sarasin*) like the Crinoids and Urchins; but there is also the possibility that in some among them, *e. g.* the less Crinoid-like forms, such as *Caryocystis* and *Megacystis*, the excretory and amœbiform functions of the ovoid gland were performed by the so-called "water-lungs," as seems to be the case in the Holothurians with no external madreporite. These organs open into the cloaca, together with the rectum, of which they are primitively diverticula, and the cloacal opening (anus) is more or less protected by valvular plates which represent the pyramid of the Cystids. In either case, therefore, it seems probable that the lateral pyramid of *Agelacrinus*, *Cyathocystis*, *Caryocrinus*, and similar forms may have been both excretory and anal in function; while the analogy of *Hymenaster* and *Pythonaster* would suggest that it also served as the outlet of the genital products, so that these types with only one recognizable opening besides the mouth might be fairly described as Cystidean Monotremes.

### 3. SOME GENERAL CONSIDERATIONS.

I have endeavoured to show in the early part of this paper that the dorsal cup of many Cystids is composed of plates which correspond respectively to the infrabasals, basals, and radials of a Crinoid. In former memoirs \* I have likewise pointed out that these plates may be recognized in the larvæ of Asterids and Ophiurids, and also in many adults of both classes †. Dorsocentral basals, and perhaps radials, occur in the larval Echinid, and all persist in the adults of some generic types; though in others only the basals and radials are traceable, as in the Blastoids, which we may fairly assume to have had a dorsocentral at the base of the stem, just like the young Crinoid, and the same may be said of the stalked Cystideans. It is curious, however, that infrabasals, which are so frequently developed in the brachiate forms, should be unknown in the Urchins and also in the Blastoids, neither class possessing definite appendages in which the ambulacra terminate; and their absence in the Blastoids is the

\* See more especially the chapter "On the Homologies of the Crinoidal Calyx in the other Echinoderms," Report on the Crinoidea, Zool. Chall. Exp. vol. xi. 1885, pp. 393-402.

† See postscript, *infra*, p. 41.

more remarkable from the fact that they are so largely developed in the Cystids, in many of which, e. g. *Pseudocrinus* and *Callocystis*, the lateral appendages of the ambulacra seem to have been of the same nature as the so-called pinnules of the Blastoids, though less numerous and more highly developed. I have the very strongest conviction that the basal and radial plates, and probably also the dorsocentral, constitute a fundamental part of the organization of every Echinoderm, except, perhaps, the Holothurians. They have not as yet been identified in any members of this class; but I think it by no means improbable that they might be found to have the same relation to the right enterocœl in the larvæ of the heavily-plated Psolidæ, as they have in other Echinoderms.

It is now some years since the publication of Lovén's classical studies of the apical system of the Urchins\*, and his comparison of it with that of a Crinoid. In the words of the cousins Sarasins†:—

“In dem ganzen so vor Durchbruch des Afters von elf Platten bedeckten Apicalpol sah nun Lovén die Hauptzüge einer Bauart, welche man bis dahin als dem Echinidentypus nicht zugehörig, sondern als charakteristisch für den Crinoidentypus betrachtete, und er benutzte dies zu einem Versuche, die Echiniden von den Crinoiden abzuleiten.”

The Sarasins speak of this appearance as the “Crinoidenfantom der Echiniden,” referring to me as one of its “emsigsten Verfolger;” and they bring a variety of arguments against a Crinoid ancestry for the Urchins, while they endeavour themselves to prove that all the classes of Echinoderms are derived, directly or indirectly, from the Holothurians.

It seems to me, however, that the so-called “Crinoidenfantom” is one of the Sarasins' own making, and that they have completely misapprehended the position of Lovén and myself. They do not refer to a single passage in Lovén's writings which indicates that he regards the Crinoids as in any way the ancestors of the Echinids. He did say, however‡:—“Dans l'une et l'autre de ces grandes classes d'Echinodermes le système dorsocentral, se présentant sous des aspects divers, est donc identique dans ses traits principaux de conformation.” Farther on in the same volume he pointed out that the dorsocentral system of a young Asterid is

\* “Études sur les Échinoïdées,” K. Svensk. Vetensk. Akad. Handl. 1874, Bd. xi No. 7, pp. 65–91.

† *Op. cit.* p. 142.

‡ *Loc. cit.* p. 72..

closely similar to that of the young Echinid, and on p. 89 he said:—

“Il existe, entre le système dorsocentral des Astériadées et celui des Échinodées, considéré dans sa totalité et dans ses rapports aux autres systèmes du test, comme dans ses parties constituantes, une similitude de structure et une conformité de modifications qui achèvent de faire concevoir tant l'unité de son plan morphologique primitif, que la nature identique du jeu des organes qui y apportent les altérations caractéristiques des unes et des autres.”

I do not know of any passage in Lovén's writings which would authorize the Sarasins in saying that he attempted to derive the Echinids from the Crinoids. They are described in his work on *Pourtalesia* \* as the “joint-heirs” of some remote ancestral type; and the Sarasins seem to have altogether forgotten or to be unacquainted with the following remarks on p. 57 of the same memoir:—

“And so close is in reality, on either side, the general conformity in structure of the geminous pores, as to cause the lineage of the Archæonomous Echinoidea to gravitate forcibly towards that group of antique Cystoidea of the Silurian era, different as these no doubt were in other respects, in the total absence—at least in the adult—of a calyx, and in the distribution of the pores all over the perisome.”

Further on, in the same work (p. 61), Lovén described his own position as follows:—

“Years ago it occurred to me, as it had to others, that the general resemblance of the ‘apical’ system in the Cidaridæ, Saleniadæ, and Echinidæ to the calyx of certain Crinoidea, might be a morphological fact of importance with regard to a true perception of the homologies of the skeletal constituents in the Echinoderms generally.”

And on the next page he says:—

“It was at a very remote geological period that the classes of the Echinoderms branched off from their ancestral trunk, at the same time inheriting in common certain important characteristics, the actual presence of which still holds together their diversified forms.”

Although differing from Lovén as regards some of the particular plates which are mutually homologous in the apical systems of Crinoids and Urchins respectively, I hold as strongly as he does that the apical system is fundamentally identical in structure in all the Echinoderm classes in which it is represented. This has been my position ever since I began to write on the subject in 1878†.

\* *Loc. cit.* p. 81.

† “On the Oral and Apical Systems of the Echinoderms,” *Quart. Journ. Micr. Sci.* 1878; vol. xviii. p. 351.

I have designedly abstained from all speculations respecting the origin of the Echinoderms, though I have once or twice alluded to various facts which seem to show that the Crinoids are in a more embryonic condition, and consequently represent an earlier phylogenetic stage than the other classes. But this is a very different thing from regarding them as the ancestral forms of the Urchins, and I would ask the Messrs. Sarasin to quote any passage from my writings which shows that I have ever held this view.

If I understand them rightly, they altogether deny that any homology can be traced between the calyx-plates of a Crinoid and those forming the primary apical system of an unstalked Echinoderm\*. They do not seem to consider the embryological evidence (which has been greatly strengthened since their memoir appeared by the researches of Fewkes† and Bury‡) as deserving of any consideration at all, for they say on p. 147, "Das Auftreten von Kreisen aus je fünf oder zehn platten bei Echiniden und Crinoiden beruht auf secundärer Vereinigung ursprünglich ungeordneter kleinerer Plättchen, analog dem Verschmelzen von primären Ambulacralplatten zu Grossplatten;" while on p. 151 they become somewhat sarcastic about the variations in the arrangement of the apical plates of Ophiurids, and the difficulty of

\* Stürtz has recently made an extraordinary blunder respecting the apical system of the Ophiurids (*loc. cit.* p. 241). Referring to Neumayr's remarks upon it, he asserts that the centrodorsal rosette of these forms represents "das Mundskelet in der dorsalen Ansicht," and he thinks that on this subject "dürfte jetzt wohl kein Zweifel mehr bestehen." Stürtz is here confusing what Boehm called "die fünfteilige Rosette" in thinly-plated disks with the rosette of primary plates in the more heavily-plated forms. The former appearance is, no doubt, due to shrinkage and to the prominence of the mouth-skeleton beneath; but if Stürtz will look at the figures of the dorsocentral systems of *Ophiomusium* and *Ophioglypha* in the early plates of Lyman's 'Challenger' Report, he will discover his mistake. The dictum that the very substantial rosette of such forms or that of *Ophiopyrgus Wyville-thomsoni* (pl. ix. figs. 16, 17) is a dorsal view of the mouth-skeleton, can only be due to an inadequate knowledge of the subject. His error is the more curious as he refers to the "Rückenappendix" of *Ophiopyrgus* on p. 244.

† "On the Development of the Calcareous Plates of *Amphiura*," Bull. Mus. Comp. Zoöl. 1887, vol. xiii. pp. 120-131; and "On the Development of the Calcareous Plates of *Asterias*," *ibid.* 1888, vol. xvii. pp. 4-45.

‡ "The Early Stages in the Development of *Antedon rosacea*," Phil. Trans. 1888, B, pp. 269-293; and "Studies in the Embryology of the Echinoderms," Quart. Journ. Micr. Sci. 1889, vol. xxix. pp. 432-445.

comparing them with those of Crinoids. Perhaps they would have been less so had they been acquainted with the structure of the genus *Acrocrinus*, in which the radials are separated from the basals by three or four rings of plates, and may also be separated laterally as well. Variations from the primitive arrangement of the same kind, though scarcely greater in degree, occur among the Ophiurids; but I do not see that this in any way affects the homologies of the basal and radial plates in the Ophiurids and Crinoids respectively.

I am glad to find, however, that the Sarasins admit the complete correspondence between the oral system of *Psolus* and that of *Hyocrinus*. But they do not seem to be aware that this was described by myself twelve years ago\*, when I also pointed out that oral plates corresponding to those of the Neocrinoids are developed in two Holothurian larvæ, besides persisting in the adult Psolidæ. We have seen that they are present in many Cystids, and they are also present in some Blastoids (*Elæacrinus*). Götte† and Bury‡ have pointed out that they are the actual representatives of the basals in the Pentacrinoïd larva; and as Wachsmuth§ took the same view of the so-called proximals in the summit of the Palæocrinoids, I was led to regard these also as orals ||, an opinion which, as we have already seen, the American authors have at last adopted¶. I have pointed out above how this doctrine is strengthened by the correspondence between basals and orals in the non-pentamerous forms, such as *Caryocrinus* and *Rhizocrinus*, a fact which I commend to the notice of the Sarasins. The mouth-plates of Ophiurids are now generally recognized as orals, and there are strong reasons for regarding the so-called odontophores of Asterids as belonging to the same category\*\*. Their presence in the Urchins is doubtful, except,

\* "On the Apical and Oral Systems of the Echinodermata, Part II.," Quart. Journ. Micr. Sci. 1879, vol. xix. p. 191.

† "Vergleichende Entwicklungsgeschichte der Comatula Mediterranea," Archiv f. mikr. Anat. 1876, Bd. xii. p. 621.

‡ Phil. Trans. 1888, B, p. 270.

§ "Notes on the Internal and External Structure of Palæozoic Crinoids," Amer. Journ. Sci. 1877, vol. xiv. p. 189.

|| Quart. Journ. Micr. Sci. 1879, vol. xix. p. 182.

¶ Proc Acad. Nat. Sci. Philad. 1888, p. 348. As already noted, this statement refers to the four anterior proximals only.

\*\* See Sladen, "On the Homologies of the Primary Larval Plates in the Test of Brachiate Echinodermis," Quart. Journ. Micr. Sci. 1884, vol. xxiv. p. 40. See also the postscript to this paper, *infra*, pp. 43, 44.



perhaps, in *Leskia mirabilis*. But so far as the other groups are concerned there can now be little doubt that the presence of five primary plates developed interradially on the left larval antimer is a fundamental morphological character. Bury \* has recently shown that the terminal plates of the Stellerid arms are the radial plates of the left antimer, corresponding to the radials of the abactinal system. They may, or may not, be present in other groups, a point which I hope to discuss at some future time. But I am most strongly of opinion that the plates forming the apical and oral systems of Echinoderms cannot be left out of consideration in any discussion respecting the phylogeny of the group; and if Semon † would modify his *Pentactula* theory to the extent of admitting that his ancestral larval form (*Pentactæa*) had both abactinal and actinal radial and interradiial plates, I should be greatly inclined to accept his general conclusions. He assumes, however, that the ancestral Echinoderm had "kein festes Skelett," and on p. 108 states his opinion that no true homologies are traceable in the apical system, "sondern nur sehr täuschende Analogieen." His acquaintance with the literature of the subject does not seem to be very extensive, for he states in a later paper ‡ how "zwei eifrige Anhänger Carpenter's wie Sladen und Bury die Terminalia der Asteroiden und Ocellarplatten der Echiniden für nicht homolog den ersten Radialia der Crinoideen halten." Semon appears to be altogether unaware that as long ago as 1884 I accepted Sladen's suggestion that the homologues of the radials of a Crinoid are to be found, not in the terminals of Asterids, but in the radial plates of the apical system §. If Semon will refer to the two papers of that date by Sladen and myself ||, or to the chapter on this subject in the "Report on the

\* Quart. Journ. Micr. Sci. 1889, vol. xxix. pp. 432-442.

† "Die Entwicklung der *Synapta digitata*, und die Stammesgeschichte der Echinodermen," Jenaische Zeitsch. Naturwiss. 1888, xxii. Bd. N. F. xv. p. 78 (of separate copy).

‡ 'Die Homologien innerhalb des Echinodermenstammes,' Morphol. Jahrb. 1889, Bd. xv. p. 299.

§ On this subject Neumayr remarked (p. 500):—"Auch bei *Zoroaster fulgens* (Quart. Journ. Micr. Sci. vol. xxiv. Taf. 1. fig. 16) ist die von Sladen als 'Radiale' bezeichnete Platte nur das grösste proximale Glied der homologen Reihe dorsaler Armtafeln." It is curious that Neumayr should not have remembered that the same description applies to the radial plates of a Crinoid.

|| Quart. Journ. Micr. Sci. 1884, vol. xxiv. pp. 3, 32.

'Challenger' Crinoids\*, he will find that our views are identical, and not divergent as he states. I freely admit that Bury thinks it probable that the oculars of an Urchin are terminals and that the primary radials are unrepresented†. But the occasional entrance of the oculars into the basal ring, and the resemblance of *Tiarechinus* to a Blastoid‡, are small difficulties in the way of accepting this view without the strong proofs which will, I hope, soon be forthcoming. It may be that the primary abactinal radials are not developed in the Urchins any more than the infrabasals are. But if the plates hitherto regarded as such should really prove to belong to the left antimer, another piece of evidence will be afforded in favour of the view that the ancestral Echinoderm had radial as well as interrarial plates developed on the actinal hemisphere, in relation with its left body-cavity.

It may be noted, too, that Bury's observations on Echinoderm larvæ answer many of the objections brought forward by the late Professor Neumayr against the views of those who believe the apical system of all Echinoderms to be constructed upon a common plan, modified though it be to a very considerable extent among the different members of the group. Neumayr attacked the subject with very great skill, but almost entirely from the palæontological side; and I do not think that he gave due consideration to the evidence either of embryology or of comparative anatomy.

To discuss his arguments in detail would be impossible now; but I hope to do so at some future time, when I shall also propose to consider the varying theories of Semon and the Sarasins, of Stürtz and Walther respecting the phylogeny and mutual relationships of the different Echinoderm classes. One point, however, and that a fundamental one, I cannot pass without notice.

Neumayr stated § that "von der richtigen Deutung des Seeigelscheitels hängt zum grossen Theile das richtige Verständniss der ganzen Entwicklung der Echinodermen ab, und ganz speciell ist hiebei das Verhältniss der Genital- und Ocellartäfelchen zueinander von grösster Bedeutung." Taking as a starting-

\* *Op. cit.* pp. 393-402.

† *Quart. Journ. Mic. Sci.* 1889, vol. xxix. p. 442. Bury's view has been adopted quite recently by Janet and Cuénot ("Note sur les Orifices Génitaux multiples," &c., *Bull. Soc. Géol. France*, tome xix. p. 303.

‡ If it be a valid argument that the oculars of an Urchin are terminals and not radials, because of their relation to the ambulacra, it is equally applicable to the radial plates of a Blastoid, which are universally accepted as homologous with those of a Crinoid.

§ *Op. cit.* p. 363.

point the Ordovician *Bothriocidaris Pahleni*, which has a single ring of ten plates enclosing the anal system, he identified five of these as the genitals and five as the oculars. He then continued:—

“ Wir können daraus mit Sicherheit schliessen dass bei den uralten Grundformen der Seeigel die Theile aus welchen sich die Genital- und Augentäfelchen der späteren Typen entwickelt haben, nicht schon zu zwei fünfzähligen, sondern zu einem einzigen, aus gleichwerthigen Stücken bestehenden zehnhzähligen Kranze angeordnet waren. Damit ist die wichtigste Frage in der ganzen Morphologie der fossilen Seeigel gelöst, oder die richtige Deutung ergibt sich wenigstens von diesem Standpunkte aus ziemlich einfach von selbst, und wir werden sehen dass dieses Ergebniss für das Verständniss des ganzen Stammes der Echinodermen von grundlegender Bedeutung ist.” (P. 364)

Neumayr made use of these statements later on in the book (p. 368) as an argument against the identification of the ocular and genital plates of an Urchin with the radial and interr radial plates developed in two rings round the apical pole in other Echinoderms, saying that the condition of *Bothriocidaris* shows the impossibility of the dicyelic arrangement being the primary one.

Neumayr's position thus depends on two fundamental assumptions:—

1. Genital and ocular plates are present in *Bothriocidaris Pahleni* and are arranged in a single ring, not in two concentric rings, as in later forms.
2. Because *Bothriocidaris Pahleni* is the oldest known Urchin, therefore we are entitled to regard the structure of its apical system as the primitive one for Urchins, and to extend this view to the other Echinoderms.

But was Neumayr right in asserting the presence of genital and ocular plates in *B. Pahleni*? Schmidt\*, in describing the genus, said expressly “ Von Genital- und Ocellarplatten keine Spur;” and neither Lovén, Agassiz, nor Zittel make any reference to their presence in this type, though Duncan† adopted Neumayr's views. It may be that the five large plates at the ends of the ambulacra are the oculars. But is it so certain that the smaller plates alternating with them are the genitals? Neumayr took this for granted, though none of his predecessors had ever suggested it, and he did not offer a single argument in support of his opinion. Schmidt considered them as the uppermost plates

\* Mém. Acad. Imp. Sci. St. Pétersb. 1874, tome xxi. No. 11, p. 38.

† “ A Revision of the Genera and Great Groups of the Echinoidea,” Journ. Linn. Soc., Zool. 1889, vol. xxiii. p. 8.

of the interambulacra\*, and the characters of these plates in *Bothriocidaris Pahleni* and *B. globulus* respectively seem to me to afford strong evidence that he is right. In *B. Pahleni* the plates of the interambulacral zones are without tubercles, and so are the supposed genital plates; but in *B. globulus* there are tubercles on the interambulacral plates and also on the so-called genitals. Neumayr made no reference whatever to Schmidt's figure of the latter species, which shows eleven plates, not ten, in the periproctal ring, while there are two others which almost enter it. Schmidt† describes the apex in the following terms:—

“Die Scheitelgegend ist complicirter gebildet, weil die Interradien in kleinen unregelmässigen länglichen Täfelchen bis zur Afteröffnung fortsetzen, und die fünf Scheiteltafeln, die auch hier auf je Einem Paar der letzten Ambulacraltafeln aufsitzen, den Kreis nicht schliessen.”

Another difficulty in the identification of these terminal interambulacral plates with the genitals of later Urchins is that they occupy a more distal position in the periproctal ring than the radially placed or supposed ocular plates do. In fact, in *B. Pahleni* one of them is excluded from the border of the periproctal ring altogether, as the edges of the radials meet inside it. Neumayr was fully aware of this‡; but it does not seem to have made him in any way doubt the correctness of his identification of these plates as genitals:—

“Wir sehen also, dass hier ein Verhältniss herrscht, welches demjenigen bei jüngeren Seeigeln gerade entgegengesetzt ist. Bei der Annahme zweier fünfzählige Kränze würden hier die Augentäfelchen den inneren, die Genitaltäfelchen den äusseren derselben bilden. Eine solche Umkehrung ist eine absolut Unmöglichkeit.”

With the last remark I am quite in accordance. But considering that there are other strong reasons against Neumayr's novel interpretation of these plates as the genitals, I cannot agree with him in attaching so much importance to the condition of *Bothriocidaris* as to make it altogether outweigh the evidence afforded by the comparative anatomy and embryology of the Echinoderms generally. Even if it be granted that Neumayr's

\* *Loc. cit.* pp. 39, 41.

† *Loc. cit.* p. 41, Taf. iv. fig. 2b.

‡ *Op cit.* p. 364.

view of these ten plates is the correct one, that is no proof that they did not develop in two rows in *Bothriocidaris* as in other Echinoderms. There are many of the later Urchins in which some or all of the oculars come into the border of the periproct and form a closed ring with the basals or genitals; and they occupy a similar position in certain Ophiurids. But all our knowledge of the comparative anatomy and embryology of these two classes goes to show that this condition is not the primitive one. Why should it be assumed, therefore, that this was necessarily the case in the antique *Bothriocidaris*? Are all the conclusions of morphology and embryology respecting the fundamental structure of a great subkingdom to be set aside in favour of those deduced from the adult characters of the earliest known fossil member of one of its classes, though by no means the most ancient representative of the subkingdom? If this be the case, the palæontologist will become the absolute arbitrator in all phylogenetic discussions; and the results of years of thought and study must at once be set aside if they are not compatible with the characters of a particular fossil, which is liable at any moment to be displaced from its position as the earliest known, and therefore the most primitive type of any group.

It seems to me that the palæontologist is here assuming too much; and as regards this particular case, a curious fact has recently been noted which goes a long way to prove the untenability of Neumayr's position. Duncan\* has pointed out that in some individuals of *Palæechinus sphericus* the radial plates are intercalated between the genitals (basals) and form with them a ring round the periproct. But, on the other hand, there are other individuals of the same species in which "the five radial plates are triangular and are only intercalated between the basal plates on the outside of the system, and they do not form a part of the ring or margin of the periproct." There is a third condition in which the radial plates are altogether absent, and the basals form a closed ring. This was represented by de Koninck†, whose figure was reproduced by Neumayr, and he proposed to make the

\* "On some Points in the Anatomy of the Species of *Palæechinus* (Scouler), McCoy, and a proposed Classification," Ann. & Mag. Nat. Hist. ser. 6, vol. iii. 1889, p. 196.

† "Sur quelques échinodermes remarquables des terrains paléozoïques," Bull. Acad. Sci. Bruxelles, 1869, 2<sup>e</sup> série, tome xxviii. p. 545, fig. 1.

original the type of a new genus *Typhlechinus* \*. Duncan's observations seem to render this unnecessary, and he was inclined to attribute the apparent absence of radial plates in de Koninck's specimen "to crush and irregular pressure, so that the radial plates were either pushed into the test or pressed away." Further investigations upon this point are much needed.

If *Palæechinus sphaericus* were the oldest known Urchin, which of these conditions would Neumayr have recognized as the typical one, and as representing the primitive structure of the apical system, not only in the Urchins, but also in the Echinoderms generally? These considerations seem to me to tell very strongly against his doctrine that this primitive type is to be found in *Bothriocidaris*, even if we assume, which I do not, that genital plates are represented in this type. If they existed, they were at any rate imperforate, and it would seem, therefore, as if the so-called anal opening may really have been a valvular osculum common to the rectum and genital ducts, like that of the *Pterasteridæ* and certain Cystids.

It is to be noted, too, that there is no distinct indication of the presence of a madreporite in this genus. It is true that Schmidt describes "ein System von länglichen Furchen und Rippen" on one of the five large plates at the apex of *B. globulus* which he identifies as the madreporite †. But he does not seem to have noticed the anomaly of its position at the end of an ambulacral zone; and the plate which he thinks is of the same character in *B. Pahleni* is similarly situated. Zittel, while mentioning the presence of a madreporite, says nothing about its radial position; while Neumayr and Duncan made no reference to it in any way. It is not clear, therefore, whether Neumayr believed it to be absent in *Bothriocidaris* or situated in an ocular plate; but in either case the application of the same principle that he employed in arriving at the primitive type of the Echinoderm apical system would lead to somewhat anomalous results. If *Bothriocidaris*, in virtue of its geological position, is to be regarded as primitive in one structural feature, we must take the same view of its other morphological characters; and the conclusion is then forced upon

\* *Op. cit.* p. 362, fig. 82 c. Neumayr described this figure somewhat inaccurately as "*Typhlechinus sphaericus* aus dem irischen Kohlenkalke. Nach Bailly." But de Koninck gave the locality as Kirkby-Stephen in Westmoreland.

† *Loc. cit.* p. 41.

us, either that the primitive Echinoderm had no madreporite at all, or that it was situated in a radial plane, so that its interradial position in later forms must be "ein Stück stark gefälschter Entwicklungsgeschichte." Even if we suppose that a madreporic canal was present but opened through the osculum, as the oviducts must have done, the facts of embryology altogether preclude the possibility of our regarding this as in any way a primitive or ancestral condition; and I believe the same to be the case with Neumayr's doctrine respecting the primitive nature of the apical system in *Bothriocidaris*.

## POSTSCRIPT (September 1891).

### 1. *The Dorsocentral System.*

It has been pointed out above (pp. 33-39) that the views of Sladen and myself respecting the fundamental identity of the abactinal or dorsocentral system throughout the calyculate Echinoderms have not been favourably received by MM. Neumayr, Semon, and Sarasin. I am glad to say, however, that Professor Perrier, who formerly contested our position, has recently adopted it.

We were led, on various grounds, to doubt the correctness of his assertion that the primary interradianal plates in the abactinal system of the young *Asterias* and *Brisinga* become the odontophores of the adult. In consequence of our criticisms, he reinvestigated the question in 1885, and still maintained that his former statements were correct\*. Even as late as 1888 he wrote:—

"Les cinq pièces interradianales deviennent, sans contestation possible, les odontophores chez les *Brisingidæ*. Les figures de Lovén, mes observations sur de jeunes *Asterias spirabilis* ne me permettent guère de douter qu'il en soit ainsi chez certains *Asteriadæ*, quoique M. Fewkes m'ait affirmé que l'odontophore se forme d'une manière indépendante chez *A. berylina*" †.

Further investigation of larval Asterids, however, and also Fewkes's published observations ‡, have quite recently led Perrier

\* "Première Note préliminaire sur les Échinodermes recueillis durant les campagnes de dragages sous-marins du 'Travailleur' et du 'Talisman.' I. Stélérides." Ann. Sci. Nat. 6<sup>me</sup> Série, Zool. tome xix. 1885, Article No. 8, p. 45.

† "Notions actuellement acquises sur l'organisation des Échinodermes," Biblioth. École d. hautes Études, Sci. Nat. tome xxxiv. 1888, Article No. 4, p. 81.

‡ Bull. Mus. Comp. Zoöl. 1888, vol. xvii. pp. 40-42.

to abandon this position\*; and he now admits that "les odontophores des *Asterias* ne font donc pas partie du calice primitif; tout au plus pourrait-on les comparer aux plaques orales des Crinoïdes," as is done by Sladen and myself.

We have likewise ventured to question the interpretation put by Perrier upon the dorsal epiproctal appendage of *Caulaster* and the *Astropectinidæ*, which he regarded as homologous with the stem of a Crinoid. He has also given up this view and has adopted the current one, that the crinoid stem is a modification of the preoral lobe of the larval Echinoderm†. Further on in this same memoir Perrier seems to adopt, though with some reserve, Sladen's theory that the primary radial plates of Asterids remain upon the disk, and are not carried out as the terminals to the ends of the growing arms, as was formerly supposed. But in a still later publication he comes over altogether to our side‡. For he describes the calycinal system of *Calycaster* (n. g.) as consisting of dorsocentral, basals, and radials; while *Prognaster* (n. g.) has infrabasals as well; and he adds, "Le squelette du disque est, en effet, exactement constitué dans ces deux genres comme le squelette typique d'un Crinoïde, et c'est pourquoi nous appellerons *calicinales* les pièces fondamentales qui le constituent."

It is with much gratification that we have watched the gradual conversion of our distinguished French colleague to our views, as the result of his own investigations of various Starfishes, both larval and adult. I still entertain hopes that both Semon and the Sarasins will adopt them whenever they can find the time for detailed comparisons of the calycinal systems in various larval Echinoderms, and also, but especially Semon, for a more extensive study of the literature of the subject. In fact, all the German authors who have recently dealt with this question (Hoernes, Neumayr, the Sarasins, Semon, Steinmann, Stürtz, and Walther) seem to be more or less imperfectly acquainted with it; and much has therefore been published which would never have been

\* 'Mission Scientifique du Cap Horn, 1882-1883,' tome vi. Zoologie. Échinodermes. I. Stellérides. Paris, 1891, p. 27.

† *Ibid.* p. 25.

‡ "Sur les Stellérides recueillis dans le Golfe de Gascogne, aux Açores et à Terre-Neuve, pendant les campagnes scientifiques du yacht 'l'Hirondelle,'" Comptes Rendus Acad. Sci. Paris, 1891, tome exii. pp. 1225-1228.



written had the author got up his subject better; and yet the literature, while by no means extensive, is easily accessible.

The worst offender, however, in this respect is Neviani, who seems to be altogether unacquainted with any of the results arrived at by the reporters on the Echinoderms of the 'Challenger' and 'Blake' expeditions, and also with the palæontological work of Messrs. Wachsmuth and Springer. *Hyponome Sarsii*, the supposed recent Cystidean from Cape York, was shown in 1879 to be merely the detached disk of an *Antedon*\*; and it was with some surprise that I found it mentioned by Neviani in his recently published article on the Phylogeny of Echinoderms†, which is so much behind the times that no further reference need be made to it.

## 2. *The Water-vascular System and its Relations.*

In a preliminary note to his forthcoming Morphological Studies on Echinoderms, Cuénot makes no reference to his former view of the "ovoid gland" as a factory of amœbocytes; but regards it as an organ of respiration and excretion, functions which may be shared by the water-vascular system, with which it is always more or less intimately associated‡. Perrier, however, continues to maintain its plastidogenic functions:—

"Chez les Stellérides, Ophiurides, et Échinides, l'appareil ambulacraire est accompagné par l'appareil *plastidogène*, qui en reproduit toutes les dispositions essentielles. Cet appareil comprend un *corps plastidogène*, qui accompagne la tube hydrophore; un *anneau plastidogène* ou *anneau de Tiedemann*, presque contigu à l'anneau ambulacraire; cinq faisceaux de *tubes plastidogènes* ou *tubes de Ludwig*, qui suivent le trajet des tubes ambulacraires"§. j

These "tubes plastidogènes" have been often described as blood-vessels, though Perrier refused to accord them this rank. I am glad to learn, however, that he admits their existence, which has been frequently denied. Like Durham, I prefer to distinguish the radial portions of the plastidogenic apparatus as the

\* "Preliminary Report upon the Comatulæ of the 'Challenger' Expedition." Proc. Roy. Soc. 1879, vol. xxviii. p. 388; and also Quart. Journ. Micr. Sci. vol. xix. 1879, pp. 14, 30.

† "Appunti sulla fillogenesi degli Echinodermi," Rivista Italiana di Scienze Naturali, Ann. xi. 1891, fasc. 2, p. 6 of separate copy.

‡ "Études morphologiques sur les Échinodermes. Note préliminaire." Arch. Zool. Exp. et Gén. 2<sup>me</sup> série, tome xix. 1891, p. xiii.

§ Biblioth. École d. hautes Études, Sci. Nat. tome xxxiv. 1888, Article No. 4, p. 71.

*hæmal* system, and to regard the remainder as mainly excretory in character, partly, of course, through its plastidogenic functions. Its relations to the ambulacral system are important in this respect, and have been well expressed by Perrier\*:—

"L'appareil plastidogène est, en grande partie, un centre formateur d'éléments anatomiques; il est à remarquer que, d'une part, il contracte des rapports intimes de contiguïté avec l'appareil ambulacraire qui communique, en général, avec l'extérieur, et que, d'autre part, il peut recevoir directement de l'appareil absorbant, quand il existe, des matières assimilables."

It is almost needless to remark that the communication with the exterior is effected by the water-pores; and in this relation some recent observations of Field's† are especially interesting. For he has discovered the presence in *Bipinnaria* of "a stage with bilaterally symmetrical water-pores, homologous in their mode of origin, and probably in function, with nephridia."

I have a strong conviction that further researches on *Balanoglossus* and *Cephalodiscus*, to say nothing of the *Tunicates* and *Amphioxus*, will throw considerable light on the comparative morphology of these intimately associated ambulacral and plastidogenic systems of Echinoderms; while the relations of the latter to the genital organs, on which Perrier lays so much stress, afford an additional reason for thinking that the osculum of the monotrematous Cystids performed a triple function, as suggested above on pp. 27–32. Beddard's discovery of anal nephridia in *Acanthodrilus multiporus* is very suggestive in this connection; and he has also shown reasons for thinking that in this type "the genital funnels and a portion at least of the ducts are formed out of nephridia"‡. He further points out that at one stage of development of this worm the nephridium branches and becomes segregated "into several almost detached tracts, communicating with the exterior by their own ducts." These are strongly suggestive of the multiple water-pores of an Echinoderm; while in a new Eudrilid recently studied by Beddard§ "the nephridial

\* *Ibid.* p. 73.

† "Contributions to the Embryology of *Asterias vulgaris*," Johns Hopkins Univ. Circ. vol. x. 1891, No. 88, pp. 101–103.

‡ "On the Homology between Genital Ducts and Nephridia in the Oligochæta," Proc. Roy. Soc. 1890, vol. xlviii. p. 455.

§ "Preliminary Notice of a New Form of Excretory Organs in an Oligochæteous Annelid," Proc. Roy. Soc. 1891, vol. xlix. p. 310.

system of the genital segments consists almost entirely of a complex system of tubes, which ramify in the thickness of the body-wall, which open by numerous pores on to the exterior, and are connected by a few short tubes with the body-cavity." With a little modification this description would be fairly applicable to the water-vascular system of an Echinoderm; and Field's observations show that there is much to be said for Hartog's conclusion \*, that "the madreporic system of Echinodermata is morphologically and ontogenetically a (left) nephridium."

### 3. *The Oscular Orifice.*

Before I had finished correcting the proofs of the preceding pages I received, through the kindness of Mr. R. A. Blair, of Sedalia, Missouri, an advance copy of the Palæontology from the Seventeenth Report of the Geological Survey of Indiana. It is from the pen of that ardent species-maker Mr. S. A. Miller, who adds fifteen more to the nineteen species of *Holocystis* which he has already described from the Niagara group of Indiana, while Hall, the founder of the genus, described another half-dozen from Wisconsin. Like the reviewer of Barrande's "Cystids" in 'Nature,' I would emphatically protest against the continued use of the termination *ites* for most generic names of Cystidea. No modern palæontologist, not even S. A. Miller, who is an ultra-conservative in all matters of nomenclature, now writes *Cyathocrinites*, *Poteriocerinites*, or *Rhodocrinites*, as did their famous author, J. S. Miller, in 1821. Why, then, do our palæontological works contain such lengthy names as *Amygdalocystites*, *Anomalocystites*, and *Strobilocystites*? The editors of Angelin's 'Iconographia' wrote *Caryocystis*, *Eucystis*, *Glyptocystis*, *Gomphocystis*, and *Megacystis* in 1878, with the remark, "Nominum genericorum exitus in *ites*, regno lapideo principio proprius, regno animali alienus;" but their example has not been followed to any great extent. The change involves a feminine termination to the specific names, and also renders a new generic name necessary, for the name *Holocystis* was given by Lonsdale in 1849 to a well-known Cretaceous coral, and *Holocystites*, Hall, only dates from 1864. Hall himself drew attention to this fact somewhat later†

\* "The True Nature of the 'Madreporic System' of Echinodermata, with Remarks on Nephridia," Ann. Mag. Nat. Hist. ser. 5, vol. xx. 1887, p. 325.

† "Twentieth Annual Report, New York State Cab. Nat. Hist.," Albany, 1867, p. 380.

with the following remark:—"The difference of the terminal syllable has in many cases been regarded as a sufficient distinction, and is perhaps preferable to adopting a new name. Should it be objected to, however, I propose the name *Megacystites*." This name, minus the terminal syllable, was adopted by the editors of Angelin's 'Iconographia,' who gave its synonymy in 1878 and described a new species from Sweden \*. Miller quotes this work, but seems to be altogether unacquainted with the change proposed by Hall. For *Megacystis* does not appear in his 'North-American Geology and Palæontology,' nor in his recent contribution to the Seventeenth Indiana Report.

Another change seems also to be inevitable. *Echinodiscus* is one of the oldest generic names among the Sea-urchins, having been founded by Breyn in 1732. Descriptions of the genus and of three of its species appear on pp. 531-534 of the 'Revision of the Echinoidea' by Alexander Agassiz. In spite of this, however, and of Scudder's 'Nomenclator Zoologicus,' Messrs. Worthen and Miller bestowed the name *Echinodiscus* in 1883 on what they believed to be a new genus of Cystids allied to *Agelacrinus* †. They state that "the mouth or ovarian pyramid is subcentral, while in *Agelacrinus* it is submarginal. This elevation would seem to be homologous with the mouth in the Echinoids, for below it, within the visceral cavity, there occur several pieces which were evidently connected with the digestive functions, and therefore homologous with the jaws in the latter order." Six years later Miller described this same opening in *Agelacrinus* as the ovarian or anal aperture ‡, while he spoke of that of *Echinodiscus* simply as the "mouth;" and in his latest publication § he describes a new species, *E. Sampsoni*, in which "the mouth is distant more than half an inch from the central point of the union of the ambulacra." Nothing could better illustrate his extraordinary confusion upon this subject and his persistent disregard of the simplest facts in Echinoderm morphology.

It has been pointed out above that *Megacystis* is one of the genera which has a third opening situated behind the mouth in the same interradius as the osculum. Miller continues to call

\* *Op. cit.* p. 29.

† 'Geological Survey of Illinois,' vol. vii. 1883, p. 335.

‡ 'North-American Geology and Palæontology,' p. 222.

§ 'Seventeenth Report of the Geological Survey of the State of Indiana,' Palæontology, p. 76.

the latter the mouth; while the real mouth (or rather its peristome) is the "ambulacral opening," whatever that may mean, and the third opening is supposed to be anal. I am inclined to regard this last as nephridial in function rather than genital, and as equivalent to the fourth opening of *Aristocystis* and *Glyptosphaera*. My reasons are as follows:—Miller describes and figures two examples of *Megacystis commoda*\*, with the remark that it has two supposed anal openings, "one in the central part of each plate between the mouth and ambulacral opening." These two specimens show the same curious variation as Barrande's examples of *Aristocystis Bohemica* which I have figured on Pl. I. figs. 10, 11. In one of them the distal opening, which I regard as genital, is on the very edge of the anal aperture, while in the other it is nearly halfway up towards the peristome, separated from it, however, by the proximal (excretory) opening. Here, again, therefore, it seems to be a fair assumption that in the ordinary forms of *Megacystis*, as also in other ditrematous Cystids, there was a common outlet for the rectum and genital ducts, while the opening nearer the peristome was an excretory one. It would seem, furthermore, that in some species of *Megacystis*† this also became absorbed into the osculum. For, while it is immediately behind the peristome in *M. Gorbyi* and *M. scitula*, it is about halfway between the peristome and the osculum in *M. bacula*, *M. cannea*, and *M. Faberi*; while in four other species, *M. Hammelli*, *M. ornata*, *M. parvula*, and *M. rotunda*, it is nearer the osculum, sometimes indeed on its very edge, as shown in Miller's figures of the two first-named. Furthermore, in the case of three species‡ Miller expressly mentions the absence of the third opening which he calls the anal aperture; while he gives good figures of the summit in well-preserved examples of five more§ in which no third opening is visible in the single plate between mouth and osculum, though its absence is not mentioned in his descriptions. There is also no reference to it in some of his other descriptions, as also in those given by Hall, whose specimens, however, were only casts.

\* *Ibid.* p. 14, pl. iii. figs. 2, 6.

† Miller's descriptions of his earlier species of *Megacystis*, or, as he calls it, *Holocystites*, will be found in vols. i. and ii. of the 'Journal of the Cincinnati Society of Natural History' (October 1878 and July 1879), and also in his 'North-American Geology and Palæontology.'

‡ *M. elegans*, *M. globosa*, *M. perlonga*.

§ *M. ornatissima*, *M. papulosa*, *M. parva*, *M. subovata*, *M. Wykoffi*.

We thus meet with the following conditions in the one genus *Megacystis*:—1. A common oscular opening for the rectum, genital and excretory ducts, as in *Agelacrinus*, *Amygdalocystis*, *Caryocrinus*, *Hemicosmites*, and *Malocystis*, (*M. elegans*). 2. A separate excretory opening near the peristome and an osculum for the rectum and genital ducts, as in *Caryocystis*, *Cystoblastus*, *Cryptocrinus*, *Glyptocystis*, *Orocystis*, *Sphæronis*, and *Sphærocystis*, (*M. Gorbyi*). 3. The excretory and genital openings independent of the osculum, as in *Aristocystis* and *Glyptosphæra*, (*M. commoda*). A fourth condition is possible, as I have suggested above, on p. 31. Where there is a single opening between osculum and peristome, but some little way from the latter (*M. bacula*), it may, perhaps, be both excretory and genital. I am inclined to think, however, that the balance of argument is in favour of considering the osculum as common to the rectum and genital ducts, like the anal spiracle of the Blastoids, unless a fourth opening is present. The third opening may therefore be generally regarded as excretory or nephridial in function, being situated sometimes in interradius CD (*Proteocystis*, *Protocrinus*, and *Sphæronis*), sometimes in DE (*Cryptocrinus*, *Cystoblastus*, and *Glyptocystis*), and sometimes in BC, as in *Eucystis* and possibly also in some forms of *Caryocystis* and *Echinosphæra*.

Several of Miller's latest figures of the summit of *Megacystis*, especially those of *M. commoda*, *M. Gorbyi*, and *M. scitula*\*, in which the peristome was more or less oblong in shape, seem to me to indicate that it was covered by a low pyramid of oral plates, which have fallen away, as is so often the case in *Cryptocrinus*, *Glyptosphæra*, and *Stephanocrinus*. The probability of this will be apparent to any one who will compare Angelin's figures of the peristome in the two former genera, the orals being preserved in some individuals and not in others†. Examples of *Stephanocrinus angulatus*, showing corresponding conditions, are represented on pl. xix. of the British Museum 'Catalogue of Blastoidea.' Miller figures and describes these oral plates in *S. Hammelli* and *S. Osgoodensis*‡; but his nomenclature is, as usual, some years behind the times. For he does not, like other palæontologists, recognize them as oral plates, reserving this name for the interradials or deltoids, a view abandoned long since by the authors

\* Seventeenth Report, Geol. Surv. Indiana, pl. ii. figs. 4, 6, pl. iii. figs. 2, 6.

† *Op. cit.* tab. xi. figs. 1, 2, tab. xii. figs. 3-5.

‡ Seventeenth Report, Geol. Surv. Indiana, pp. 23, 25, pl. vi. figs. 3, 7.

of the Blastoid Catalogue and also by Messrs. Wachsmuth and Springer. It is quite refreshing, however, to find him speaking of "the central part of the ambulacral area or mouth." Why cannot he always do so?

Miller likewise gives a good figure showing the summit-plates in his new species *Caryocrinus Indianensis* \*. The six central plates, orals, as I regard them, are plainly visible; but the two anterolaterals are separated from the interradians (13, 18) by smaller plates, instead of coming into direct contact with them, as in the specimens of *C. ornatus* kindly lent me by Mr. Wachsmuth, one of which I have figured (Pl. I. fig. 14). I do not remember that the latter condition has yet been described in *Caryocrinus*, though it possibly presents itself in the specimens figured by Hall † and Zittel ‡. It is a point of some importance as regards the homologies of these summit-plates, for in *Stephanocrinus*, *Elæocrinus*, and in some species of *Platycrinus*, the orals also come into direct contact with the interradians. In Mr. Wachsmuth's specimen the tegmen is much depressed along the lines of these two anterolateral interradians, and Miller says that in *C. Indianensis* it is "depressed, convex, and sunken between the arm clusters so as to give it a wavy surface. The central plate is large, heptagonal; it is surrounded by seven plates that cover nearly the whole summit. Two of the seven plates curve upward and surround two-thirds of the prominent azygous opening." The central plate, together with five of the seven around it, are the orals, the other two belonging to the anal system, just as is shown in Hall's figures of the summit of *C. ornatus*, or in Mr. Wachsmuth's specimens. Miller, however, describes the "vault" of *C. Indianensis* as "different from that of *C. ornatus*, the structure of which Wachsmuth thought was generic." But the only point of difference is that in some individuals of *C. ornatus* a third anal plate comes up into line with the other two, just behind the posterior oral; and this led Wachsmuth to describe the latter as surrounded by eight plates §, while Miller only finds seven in *C. Indianensis*. This difference, however, is certainly not of specific value, and I am inclined to think that the same may be said of the other characters on which Miller founded the species *Caryocrinus Indianensis*.

\* *Ibid.* p. 19, pl. v. fig. 10.

† 'Palæontology of New York,' vol. ii. pl. 49. fig. 1 v, pl. 49 a. fig. 1 e.

‡ 'Palæontologie,' Bd. i. p. 419, fig. 295 b.

§ See *suprà*, pp 19, 20.

## EXPLANATION OF PLATE I.

- Fig. 1. Analysis of the dorsal cup of *Hemicosmites pyriformis*. Copied from Von Buch (Abhandl. Berlin Akad. 1844, Taf. ii. fig. 10).—*ib*, 1-4, infrabasals; *b*, 5-10, basals; *r*, 11, 12, 14-17, radials; *i*, 13, 18, A, interradials.
- Fig. 2. Analysis of the dorsal cup of *Caryocrinus ornatus*. Copied from Hall ('Palæont. New York,' vol. ii. pl. 49. fig. 1 y).—Lettering as in Fig. 1.
- Figs. 3-7. A-E, the five rays; 1-4, infrabasals; 5-9, basals; 10-14, radials; 15-19, first series of perisomic plates (interradials?).—N.B. The numbering of the plates is not always identical with that employed in the original figures.
- Fig. 3. Analysis of the dorsal cup of *Echinoencrinus armatus*, var. Copied from Forbes (Mem. Geol. Survey, vol. ii. pl. xix. fig. 5) with the addition of a pore-rhomb, occasionally present on plates 12-18.
4. The dorsal cup of *Echinoencrinus angulosus*, developed laterally. Copied from Von Buch (Abhandl. Berlin Akad. 1844, Taf. ii. fig. 7).
5. Analysis of the dorsal cup of *Callocystis Jewetti*. Copied from Hall ('Palæontology of New York,' vol. ii. pl. 50. fig. 11).
6. Analysis of the dorsal cup of *Lepadocrinus Gebhardi*. Copied from Hall ('Palæontology of New York,' vol. iii. pl. 7. fig. 23).
7. Side view of the calyx of *Cystoblastus Leuchtenbergi*. Copied from Volborth (Mém. St. Pétersbourg Acad. 1870, tome xvi. no. 2, fig. 14).—*b*, osculum; *c*, excretory (?) opening.
8. The dorsal cup of *Glyptocystis multipora*, developed laterally. Copied from Quenstedt 'Atlas, Asteriden und Encriniden,' tab. 113. fig. 83.
9. The dorsal cup of *Cryptocrinus cerasus*, developed laterally. Based on Von Buch's figure (Abhandl. Berlin Akad. 1844, Taf. ii. fig. 5).
- Figs. 10, 11. Internal and external views of the oral pole of *Pyrocystis desiderata*. Fig. 10 shows the subtegmina ambulacra (hydrophores, *Barrande*), and fig. 11 the low pyramid of oral plates above the mouth. Copied from Barrande (Syst. Silur. de Bohême, vol. vii. pl. 29. figs. 32, 33).
- Fig. 12. The oral pole of *Aristocystis Bohemica*. Copied from Barrande (Syst. Silur. de Bohême, vol. vii. pl. 9. fig. 17).—*a*, mouth; *b*, anus; *c*, genital pore; *d*, excretory (?) opening. The genital pore is on the edge of the anal opening.
13. A similar view of another specimen, with the genital pore further removed from the anal opening. Copied from Barrande (Syst. Silur. de Bohême, vol. vii. pl. 9. fig. 6).
14. Summit of *Caryocrinus ornatus*, from a specimen belonging to Mr. Wachsmuth.—*b*, anus; *o*, oral plates; *r* (11, 12, 14-17), radials; *i* (13, 18), interradials.
15. Portion of the summit of *Glyptosphaera Leuchtenbergi*, showing—*a*, the low pyramid of oral plates above the mouth; *b*, the anus; *c*, the genital pore; *d*, the excretory (?) opening, possibly a madreporite. From Quenstedt 'Atlas, Asteriden und Encriniden,' tab. 114. fig. 10.



Notes on some Arctic Comatulæ. By P. HERBERT CARPENTER,  
D.Sc., F.R.S., F.L.S., Assistant Master at Eton College.

[Read 4th June, 1891.]

(PLATE II.)

THE object of this paper is to endeavour to clear up some of the uncertainty which appears to exist in the minds of those naturalists who have had occasion to study the Arctic Comatulæ, respecting the characters of one or two widely distributed species, and more especially that which was described by Duncan and Sladen under the name of *Antedon prolixa* \*. It has been recently regarded as only a full-grown and highly developed form of the small *Antedon tenella*, Retzius, sp., which is better known to European naturalists under the name of *Antedon Sarsii*; but I hope to show that this view is incorrect, and only results from an imperfect acquaintance with the characters of the last mentioned type. The validity of another Arctic species, that which I have called *Antedon quadrata*, has also been challenged, owing to the resemblance between its younger stages and those of *Antedon Eschrichti*, though more mature individuals of the two types have seemed very distinct to those who have compared them directly.

One, if not both, of these disputed species, *Antedon quadrata* and *A. prolixa*, was discovered by the 'Porcupine' in 1869 in the cold area of the Faroe Channel; but they remained without notice for some years. In 1872-3, however, they were both obtained by the ill-fated 'Tegetthoff' in the neighbourhood of Nova Zembla and Franz Joseph Land respectively; and they were referred by von Marenzeller † to *Antedon celtica*, Barrett, and *A. Sarsii*, Düben and Koren. Their subsequent history may be summarized as follows:—

Specimens obtained

by:—

1877. The 'Tegetthoff.'	{	A. Referred to <i>Antedon celtica</i> , Barrett, by von Marenzeller.
	{	B. Referred to <i>A. Sarsii</i> by von Marenzeller.

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\* 'A Memoir on the Echinodermata of the Arctic Sea to the West of Greenland' (London, 1881), p. 77.

† "Die Cœlenteraten, Echinodermen und Würmer der k. k. Oesterreichisch-Ungarischen Nordpol-Expedition," Denkschr. d. k. Akad. d. Wiss. Wien, 1877 [1878], Bd. xxxv. pp. 380-382.

## Specimens obtained.

1881. H.M.S. 'Alert' ..... { A. Referred to *A. celtica*, Barrett, by Sladen.  
B. Described as *A. proluxa* by Sladen.
1882. .... Originals of *Antedon celtica*, Barrett, referred to *A. phalangium* by Carpenter.
1883. The 'Tegetthoff' ... A. }  
H.M.S. 'Alert' ..... A. } Described as *A. quadrata* by Carpenter.  
H.M.S. 'Triton' ... A. }  
H.M.S. 'Valorous' . A. }
1883. H.M.S. 'Porcupine' B. } Referred to *A. dentata* (*Sarsii*, auct.) by  
H.M.S. 'Triton' ... B. } Carpenter.
1883. H.M.S. 'Porcupine' C. } Described as *A. hystrix* by Carpenter.  
H.M.S. 'Triton' ... C. }
1885. The 'Vöringen' ... A. Referred to *A. celtica* by Nansen.
1886. .... *Antedon quadrata*, Carpenter, referred to *A. Eschrichti* by Levinson.
1886. The 'Willem Barents' { A. Referred to *A. quadrata* by Carpenter.  
B. Referred to *A. dentata* by Carpenter.
1886. The 'Tegetthoff' ... A. )  
H.M.S. 'Alert' ..... A. )  
H.M.S. 'Triton' ... A. ) Referred to *A. quadrata* by Fischer.  
And those from Jan  
Mayen ..... A. )
1886. The 'Tegetthoff' ... B. )  
H.M.S. 'Alert' ..... B. ) Referred to *A. dentata* by Fischer.  
And those from Jan  
Mayen ..... B. )
1887. The 'Varna' ..... { A. Referred to *A. quadrata* by Carpenter.  
B. Referred to *A. proluxa* by Carpenter.
1888. The 'Tegetthoff' ... A. )  
H.M.S. 'Alert' ..... A. )  
H.M.S. 'Triton' ... A. )  
H.M.S. 'Valorous' . A. ) Referred to *A. quadrata* by Carpenter.  
The 'Willem Barents' A. )  
The 'Varna' ..... A. )  
And those from Jan  
Mayen..... A. )
1888. The 'Tegetthoff' ... B. )  
H.M.S. 'Alert' ..... B. )  
The 'Vöringen' ... A. ) Referred to *A. proluxa* by Carpenter.  
The 'Varna' ..... B. )  
And those from Jan  
Mayen... ..... B. )
1888. H.M.S. 'Porcupine' B. } Referred to *A. tenella* (= *A. dentata* = *A.*  
H.M.S. 'Triton' ... B. } *Sarsii*) by Carpenter.  
The 'Willem Barents' B. }
1888. H.M.S. 'Porcupine' C. } Referred to *A. hystrix* by Carpenter.  
H.M.S. 'Triton' ... C. }

1. *Antedon quadrata* \*, *Carpenter*.

Levinsen † has recently denied the distinctness of this species from *Antedon Eschrichti* on the ground that its characters, as stated by von Marenzeller and Sladen, and in my own preliminary description, all present themselves in immature examples of *A. Eschrichti*. He has not, however, seen any authentic specimens of it, so that he has not had the opportunity of comparing them with equal-sized but still immature examples of *A. Eschrichti*. This I have been able to do, as explained in my Report on the 'Challenger' Comatulæ ‡; and I am still inclined to agree with Sladen in keeping the two species distinct. He is the only other naturalist besides myself who has had the means of directly comparing mature examples of the two species which were obtained at the same locality; and neither von Marenzeller nor Sladen ever seem to have had any suspicion that the forms which they were describing as *Antedon celtica* might be young examples of *A. Eschrichti*. Neither do I think that this view would occur to any one familiar with *A. Eschrichti* who examined the fine specimen of *A. quadrata* obtained by the 'Varna' in the Kara Sea §, the general facies of the two forms being altogether different.

2. *Antedon prolixa*, *Sladen*. (Plate II. figs. 1-4, 6.)

Fæilden's dredgings at Discovery Bay during Sir George Nares's Arctic Expedition of 1875-76 yielded some specimens of an *Antedon* which Sladen took to be new; but, as we shall see subsequently, it had been already obtained, though not described, both by the 'Porcupine' and by the 'Tegetthoff.' Sladen gave a careful diagnosis of the type under the specific name *prolixa* ||; and when the 'Varna' Comatulæ from the Kara Sea came into my hands I found two examples of this form among them ¶.

In the following year Dr. Fischer published his account of the Echinoderms which he had collected at the Austro-Hungarian

\* The synonymy of this species will be found on p. 149 of the Report on the 'Challenger' Comatulæ.

† "Kara-Havets Echinodermata," *Dijmphna-Togtets zoologisk-botaniske Udhytte*, Kjöbenhavn, 1886, p. 413.

‡ Zool. Chall. Exp. vol. xxvi. 1888, pp. 150-156.

§ "Zoölogische Bijdragen tot de Kennis der Karazee: II. Report on the Comatulæ," *Bijdragen tot de Dierkunde*, 1887, 14. Afl. p. 42. fig. 1.

|| *Op. cit.* p. 77.

¶ 'Report on the Comatulæ of the Kara Sea,' p. 44, figs. 2, 3.

Polar station in Jan Mayen, the principal Crinoid occurring there being a large *Antedon* which he referred at once to *A. proluxa* \*. He also obtained a second, but less mature individual, two others quite young, and two Pentacrinoids, which last "vollkommen mit den Beschreibungen übereinstimmen, die Sars in seinen 'Mémoires des Crinoïdes vivants' gibt, und auf Taf. v. und vi. abbildet. Die von Jan Mayen mitgebrachten Exemplaren entsprechen dem Entwicklungsstadium, wie es Sars auf Taf. v. fig. 9 entwirft." The figure referred to represents, I need hardly say, the Pentacrinoid stage of *Antedon Sarsii*, now known as *A. tenella* †; and we shall have to consider later on whether the correspondence between the Jan Mayen larvæ and those of *A. tenella* really is so complete as Fischer supposed. He also states that the two young specimens mentioned above "tragen sämtliche von Düben & Koren und den späteren Autoren für *Antedon Sarsii* angegebenen charakteristischen Merkmale;" but he does not seem to have ever directly compared them with examples of this well-known Scandinavian type, of which the Vienna Museum possesses numerous examples. This would have been a more satisfactory means of identification than the use of descriptions written over forty years ago and, as is only natural, insufficient for the purposes of specific discrimination in these later times. But although Fischer neglected to compare his youngest individuals from Jan Mayen with typical examples of *Antedon tenella*, he did compare his two largest individuals of *A. proluxa* with the two specimens from the 'Tegetthoff' Expedition which von Marenzeller had considered to be large examples of *A. Sarsii (tenella)*, having longer cirri with more numerous joints than the typical Scandinavian form. He was good enough to send them to me for examination early in 1881, and at that time I did not see how otherwise to regard them, as I had not then seen *A. proluxa*, and the possibility of their being immature forms of this type did not occur to me, though I now know that such is the case.

Fischer, therefore, relying upon the identification by von Marenzeller and myself of the two 'Tegetthoff' specimens with *Antedon Sarsii (tenella)*, and finding his two largest examples of *A. proluxa* from Jan Mayen to agree closely with the former pair, naturally concluded that the latter should also receive the same

\* "Echinodermen von Jan Mayen," Die Oesterreichische Polarstation Jan Mayen, Bd. iii. 1886, p. 29.

† See the Report on the 'Challenger' Comatulæ, p. 172.

name; and he was strengthened in this opinion by his comparison of the two youngest individuals from Jan Mayen and also of the Pentacrinoids with the descriptions of *A. Sarsii* and its larva. He expressed his conviction, therefore, "dass unter *Antedon prolixa*, Sladen, nur ausgewachsene Exemplare von *A. Sarsii*, welche bislang noch nicht erschöpfend beschrieben waren, zu verstehen sind."

Under these circumstances it seemed desirable that the characters of these two species should be re-investigated, and direct comparisons made of all the available material. The types of *Ant. prolixa* are in the National Collection, while the two examples of it obtained by the 'Varna' in the Kara Sea are still in my keeping, together with numerous specimens of *A. Sarsii* (*tenella*) obtained by the 'Porcupine,' 'Triton,' 'Blake,' 'Willem Barents,' &c.; while, thanks to the kindness of Dr. von Marenzeller, I have been enabled to compare these individuals with the two original 'Tegetthoff' specimens, and also with all those obtained by Dr. Fischer at Jan Mayen. Careful investigation of all this material has convinced me that *Antedon prolixa* is a good species, and quite distinct from *A. tenella*. Both the two 'Tegetthoff' specimens and also Sladen's types are immature individuals, Fischer's largest example from Jan Mayen (Pl. II. fig. 4) being the first fully grown one yet obtained. Since seeing this, too, I have no longer any doubt that the *Antedon hystrix* which was dredged by the 'Porcupine' and 'Triton' in the cold area of the Faroe Channel, and by the Norwegian North-Atlantic Expedition from 743 fathoms near Spitzbergen\*, should also be referred to *A. prolixa*, a possibility which I mentioned when discussing *A. hystrix* in the 'Challenger' Report †.

The two specimens dredged by the 'Porcupine' in 1869 thus prove to be the first discovered individuals of *A. prolixa*; but neither they nor those from the 'Tegetthoff' were recognized as new to science at the time; and the species was first described by Sladen from the less mature individuals brought home by Sir George Nares's Arctic Expedition of 1875-76.

The essential points of difference between *Antedon prolixa* and

\* This is the *Antedon celtica* mentioned by Nansen in his 'Bidrag til Myzotomernes Anatomi og Histologi,' Bergen, 1885, p. 6. I am indebted to the kindness of Dr. Nansen for specimens of the type, dredged by the 'Vöringen.

† *Op. cit.* p. 167.

*A. Sarsii* (*tenella*) are as follows:—1, Size; 2, the Cirri; 3, the Radials; 4, the Shape of the Arm-joints; 5, the Syzygies.

1. The Scandinavian variety of *Antedon tenella* is much smaller and less robust than that found in the deeper water of the Atlantic, both east and west. The examples dredged by the 'Blake' off the New England coast are the largest which I have seen; but the disk is not more than 7 mm. in diameter, while the maximum length of an arm scarcely reaches 70 mm. On the other hand, Fischer's largest individual of *A. proluxa* from Jan Mayen has a disk 10 mm. in diameter, and he measured one arm as 120 mm. long, adding "Es fehlt jedoch ein gutes Stück von der Spitze des Armes." This difference in size between the two types would, of course, be unimportant alone; but taken together with those other differences now to be described, it may, I think, be regarded as affording a good specific character.

2. The Scandinavian variety of *Antedon tenella* usually has but 18 or 20 cirrus-joints, while there may be 25 in those from the Faroe channel and Kara Sea, and 28 or 30 in the American variety, with a maximum length of 24 mm. These dimensions are very different from those of the individuals which have been referred to *A. proluxa*, as will be seen from the following Table:—

*Antedon tenella* ..... Longest cirri of American variety 24 mm., with 30 joints.  
(*Sarsii*, auct.).

*Antedon proluxa*.

'Tegetthoff' .....	Longest cirri.....	37 mm., with 33 joints.
Jan Mayen .....	Longest cirri.....	60 mm., with 43 joints.
Sladen's types.....	Longest cirri.....	60 mm., with 45 joints.
'Porcupine' .....	Longest cirri.....	50 mm., with 45 joints.
'Varna' (immature).	Longest cirri.....	35 mm., with 35 joints.
'Vöringen' .....	Longest cirri.....	35 mm., with 40 joints.
A specimen from Finmark in the British Museum	} Longest cirri.....	35 mm., with 41 joints.

See also the measurements given on p. 176 of the Report on the 'Challenger' Comatulæ.

3. If Fischer be right in his supposition that *Antedon proluxa* is merely the fully grown form of *A. Sarsii* (*tenella*), one would of course expect that the individuals referred to the latter type

would present more embryonic characters than those of *A. proluxa*. This, however, is exactly contrary to the real state of the case. Both the calyx and the arm-joints of *A. tenella* exhibit characters of greater maturity than equal-sized or even larger examples of *A. proluxa*. Thus, for example, in the large Atlantic variety of *A. tenella* the radials are barely visible (Pl. II. fig. 7); and they are only traceable in younger individuals as a narrow band round the edge of the centro-dorsal (fig. 6). But this is much broader in the calyx of the nearly equal-sized but still immature *A. proluxa* from the 'Tegetthoff' expedition (fig. 2); so that it presents an appearance similar to that of the embryonic types *A. abyssicola* and the genus *Atelecrinus*. Even in the larger 'Tegetthoff' specimen, which is of much greater size than any *Antedon tenella* I have ever seen, a considerable portion of the radials appears externally, and the full-grown *A. proluxa* from Jan Mayen (fig. 4) shows more of them than the largest *A. tenella* of the 'Blake' dredgings, though the latter is absolutely of much smaller size (fig. 7).

4. What has been said above concerning the radials holds good also for the costals and lower brachials, which are relatively longer and more embryonic in the immature *A. proluxa* than in the largest and best-developed individuals of *A. tenella*. This difference, however, is most apparent when the two young specimens of *A. proluxa* from Jan Mayen are compared with equal-sized examples of *A. tenella* from the North Sea. Fischer states that the former present all the characters which are given by Düben and Koren and later authors as characteristic of *A. Sarsii*. But Düben and Koren's description of this type is over forty years old, and not of much value therefore for systematic purposes at the present time, while subsequent writers have added little of importance to it. A direct comparison of Fischer's two specimens with typical examples of *A. tenella* leads to very different results. Their cirri are considerably larger than those of a Scandinavian form of equal size which has well-developed genital glands and all the other characters of maturity. Its radials are almost entirely concealed, while in Fischer's specimens a considerable portion of them is visible, as described above. Similar differences appear between the lower brachials of the two forms, as will be evident from a glance at figs. 3 and 5 on Plate II. Those of the young *A. proluxa* are much elongated, and present all the characters of immaturity; while in the arm of *A. tenella* of

the same size the joints are as wide or wider than long, and present the shape characteristic of the adult individual. The difference is so marked, that Fischer can hardly have overlooked it, if he really did compare the two types; and it indicates very clearly that *A. proluxa* and *A. tenella* are by no means so closely identical as he supposes.

5. The length of the syzygial intervals throughout the arms is also very different in the two forms. I have carefully examined a large number of arms of *A. tenella* from many different localities; and I find that after the third syzygy, which is almost invariably in the twelfth brachial, the syzygial interval is normally only two joints. The second interval may sometimes be two instead of three, and more rarely four; so that the third syzygy comes on the 11th or 13th, instead of on the 12th brachial; but the remaining syzygies occur almost invariably on every third joint. The interval is sometimes, though rarely, increased to three joints; but I have never found it rising to four or five, as mentioned in Müller's description of the type\*. In three of the longest unbroken arms which I have met with the succession of intervals was—

2 2 2 2 2 2 2 2 2 2 2 2 2 or  $2^{15}$ ,  
 2 2 2 2 2 2 2 2 2 3 2 2 2 2 or  $2^{10}$ , 3,  $2^4$ ,  
 2 2 2 3 2 2 2 2 2 2 2 2 2 2 or  $2^3$ , 3,  $2^{11}$ .

I have also examined twenty specimens of *A. proluxa* from seven different localities, and have recorded the sequence of the syzygies in the five longest arms remaining to each. I find that the syzygial interval is generally 3 joints, but may sometimes be 4, 5, or 6; so that the third syzygy may come anywhere from the 12th to the 15th brachial. The following intervals may be of 1-6 joints, 3 being by far the most frequent, sometimes occurring sixteen times in succession, though intervals of 2 joints are not uncommon, especially in the first third of the arms. The following Table shows the distribution of the syzygies in the different groups of individuals which I have examined.

\* "Ueber die Gattung *Comatula*, Lam., und ihre Arten," Abhandl. d. k. Akad. d. Wiss. Berlin [1847], 1849, p. 254.



	Sladen's types.	'Porcu- pine.'	'Vöringen.'	Kara Sea ( 'Varna' & Finmark).	'Tegett- hoff.'	Jan Mayen.	Total.
No. of individuals :	5	3	5*	3	2	2	20
Interval of							
1 joint .....	0	0	6	3	0	4	13
2 joints .....	32	26	150	55	39	53	355
3 joints .....	64	78	192	63	65	102	564
4 joints .....	4	22	53	17	5	1	102
5 joints .....	1	7	19	7	0	0	34
6 joints .....	0	2	2	0	0	0	4

*Typical Arms.*

3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 2 3, or 3<sup>16</sup>, 2, 3,  
4 5 4 4 4 4 5 6 5 4 3 5 4 4 4 2 5,  
3 4 3 4 4 5 5 5 3 3 4 3 4 3 3,  
2 3 3 2 3 4 3 5 2 3 5 4 2 4,  
2 2 2 3 2 2 2 3 2 2 2 3 2 3 2 5 3 4 2 3.

From these data it may, I think, be fairly concluded that the typical number of joints in the syzygial intervals of *Antedon prolixa* is 3, as in *A. Eschrichti*; while in *A. tenella* there are not more than 2, as in the allied species *A. exigua*. This character, taken in connection with those of the cirri, radials, and arm-joints, serves to distinguish the two species very clearly; and I see no reason for uniting them, as Fischer has done.

He supports his views by remarking\* :—"Sollten noch irgend welche Zweifel entstehen, so werden dieselben wiederlegt durch die Thatsache, dass ich gleichzeitig mit den bereits beschriebenen Exemplaren zwei *Pentacrinus*-Stadien auf einer *Rhynconella* aufsitzend fand, die vollkommen mit den Beschreibungen übereinstimmen, die Sars in seinen 'Mémoires des Crinoïdes vivants' gibt, und auf Taf. v. und vi. abbildet. Die von Jan Mayen mitgebrachten Exemplare entsprechen dem Entwicklungsstadium, wie es Sars auf Taf. v. fig. 9 entwirft." An enlarged view of the head of this individual is given by Sars in fig. 11 of the same plate, which I have copied on Plate II. fig. 8, in order to compare it with the Jan Mayen larva, which Dr. von Marenzeller has kindly sent me for examination (fig. 1). They are, as Fischer remarks, at the

\* *Loc. cit.*, p. 30.

same stage of development, with the first whorl of cirri just forming; but I cannot see the complete correspondence between the two on which he lays so much stress. Sars gave the dimensions of his larva as follows:—

Stem of 49 joints ..... 21 mm. long.

Head and 18-20 arm-joints .... 4 ,,

His figure also shows the first costals to be nearly square, and the axillary longer than wide, while the cirri are quite rudimentary, only just reaching above the basi-radial suture (fig. 8). Now in the Jan Mayen larva one cirrus at least is much better developed, having well-defined joints, and almost reaching up to the level of the first brachials; while the costals present characters of much greater maturity, the first being oblong and the axillaries wider than long (Pl. II. fig. 1). It is altogether more robust than the larva of *A. tenella*, as the following measurements show:—

Stem-fragment of 26 joints .... 14 mm. long.

Head and 8 arm-joints ..... 4 ,,

This greater robustness at the same developmental stage is, of course, only to be expected if the Jan Mayen larva belongs to *A. proluxa*, which reaches such a much larger size than *A. tenella* in the adult condition; while, as was pointed out on pp. 177-178 of the 'Challenger' Report, there is a fallacy in Fischer's argument respecting these Pentacrinoids, which altogether vitiates his conclusions as to the identity of *A. tenella* and *A. proluxa*. I am well acquainted with the various developmental stages of *A. tenella*, and should certainly not refer the Jan Mayen larva to this species. It is, however, very closely similar to a larva dredged by the 'Porcupine' in the cold area of the Faroe Channel, which I figured in the 'Challenger' Report\*. The first costals of this larva are oblong, and the axillaries wider than long; while its measurements are as follows:—

Stem-fragment of 30 joints .... 20 mm. long.

Head and 10 arm-joints ..... 4 ,,

This 'Porcupine' larva and that from Jan Mayen undoubtedly belong to the same species. The former is quite different from the Pentacrinoids of *Antedon tenella* and *A. Eschrichti*, which were dredged in the same locality; and I was therefore led to refer it

\* *Op. cit.* pl. xiv. fig. 3.

to *Antedon hystrix*, which is also an inhabitant of the cold area. But this species now turns out to be identical with *Antedon proluxa*; and the resemblance of the 'Porcupine' larva to that found at Jan Mayen, together with the adult *A. proluxa*, is therefore an important piece of evidence against Fischer's identification of *Antedon proluxa* with *A. tenella*.

## SUMMARY.

<i>Tenella</i> , Retzius, = <i>dentata</i> , Say, = <i>Sarsii</i> , Düben & Koren.	<i>Proluxa</i> , Sladen, = <i>hystrix</i> , Carpenter, = <i>celtica</i> , Nansen.	<i>Quadrata</i> , Carpenter, = <i>celtica</i> , Marenzeiler.
H.M.S. 'Porcupine,' B.	H.M.S. 'Porcupine,' C.	The 'Tegetthoff,' A.
H.M.S. 'Triton,' B.	The 'Tegetthoff,' B.	H.M.S. 'Valorous,' A.
The 'Willem Barents,' B.	H.M.S. 'Alert,' B.	H.M.S. 'Alert,' A.
	H.M.S. 'Triton,' C.	H.M.S. 'Triton,' A.
	The 'Varna,' B.	The 'Willem Barents,' A.
	The 'Vöringen,' A.	The 'Varna,' A.
	Those from Jan Mayen, B.	Those from Jan Mayen, A.
	Aspecimen from Finmark in the British Museum.	

## EXPLANATION OF PLATE II.

- Fig. 1. Pentacrinoid of *Antedon proluxa*, from Jan Mayen.  $\times 10$ .
2. Calyx and arm-bases of an immature *A. proluxa*, from the 'Tegetthoff' expedition.  $\times 4$ .
3. Portion of an arm of a young *A. proluxa* from Jan Mayen. (Br. 2-10).  $\times 6$ .
4. Full-grown individual of *A. proluxa*.  $\times 4$ .
5. Portion of an arm of *A. tenella*. (Br. 5-16).  $\times 6$ .
6. Calyx and arm-bases of an immature *A. tenella*, from the West Atlantic.  $\times 4$ .
7. Calyx and arm-bases of a full-grown individual from the same locality.  $\times 4$ .
8. Pentacrinoid of *A. tenella*. Copied from Sars.

Notes on some Crinoids from the Neighbourhood of Madeira.

By P. HERBERT CARPENTER, D.Sc., F.R.S., F.L.S., Assistant Master at Eton College.

[Read 4th June, 1891.]

MR. J. Y. JOHNSON, of Funchal, has recently been kind enough to send me specimens of various Crinoids which he has obtained from time to time in the neighbourhood of Madeira. None of them are new, but their occurrence in this locality is interesting, from its bearing on the question of geographical distribution. Three of them—*Pentacrinus Wyville-Thomsoni*, *Antedon phalangium*, and *A. lusitanica*—were found attached to a cable belonging to the Brazilian Submarine Telegraph Company, which was recently taken up for repair from a depth of 500–700 fathoms. Mr. Johnson tells me that “when hauled up, a great many objects were found attached to it; but as no stranger was allowed to go on board, and as the official people were too much occupied or too indifferent to Natural History to give themselves trouble in that direction, it was only with much difficulty, and by special favour, that I succeeded in securing a few objects, all of them, unfortunately, more or less injured.” It is much to be regretted that engineers in charge of ocean cables do not more generally follow the now classical example of the late Professor Fleeming Jenkin, whose careful preservation of the animals on the Mediterranean cable which he picked up in 1860 led to such important results.

1. PENTACRINUS WYVILLE-THOMSONI, *Jeffreys*. (See the Report on the Crinoidea, Zool. Chall. Exp. vol. xi. 1884, p. 313, pls. xviii.–xxiv.)

This species is represented by one adult and some young individuals, one of the latter having but thirteen arms, a number rather smaller than usual.

The original examples of this type were obtained by the ‘Porcupine’ off Cape Carvoeiro on the Portuguese coast, from a depth of 1095 fathoms. It has since been dredged by the ‘Talisman’ in 1480 metres off Rochefort; in 1917 metres off

Cape Cantin on the Morocco coast; and again in 1435 metres between the Canaries and Cape Verd Islands\*.

Its discovery in the neighbourhood of Madeira somewhat increases its geographical range to the westward, and it is probably pretty generally distributed in the North Atlantic east of the meridian of  $20^{\circ}$ , between the parallels of  $20^{\circ}$  and  $45^{\circ}$  N. latitude. Curiously enough, however, neither it nor any Comatulæ were obtained by the 'Challenger' in any of the dredgings round the Azores, Canaries, or Cape Verd Islands. The 'Talisman' dredged Comatulæ in the neighbourhood of each group at various depths, down to 2300 metres; but her explorations in the Sargasso Sea seem to have been as unproductive of Crinoids as those of the 'Challenger.'

2. *ANTEDON LUSITANICA*, Carpenter. (See the Report on the Comatulæ, Zool. Chall. Exp. vol. xxvi. 1888, p. 109, pl. xxxix. figs. 1-3.)

Three examples of this species were obtained by Mr. Johnson from the Brazilian cable, thus extending its geographical range very considerably. The originals of the type were dredged by the 'Porcupine' in 740 fathoms off Cape Carvoeiro, together with some fragments of *Pentacrinus Wyville-Thomsoni*; and the renewed association of these two species on the cable near Madeira is therefore of interest. I think it very probable that the Comatulæ obtained by the 'Talisman' in depths of about 1200 metres off the Azores and Canaries, in 2200 metres off Agadir, and in 2330 metres near the Cape Verd Islands may belong to this deep-sea type. The former, however, might possibly also include *Antedon phalangium*, which is now known to extend down to at least 500 fathoms.

All Mr. Johnson's three specimens of *Antedon lusitanica* are

\* It is much to be regretted that so little has yet been published respecting the results of the numerous dredgings made by the 'Talisman' in this portion of the Atlantic, during the summer of 1883. A brief, but useful epitome of the cruise has been given by the Marquis de Folin, in a small volume entitled "Sous les Mers" (Paris, 1887), from which I have obtained the data respecting the stations at which Crinoids were dredged, to which reference is made above. But the publication of the detailed reports on the various groups seems likely to be even longer delayed than were those of the 'Challenger'; for the work is entirely in the hands of a small number of French naturalists, who have no special knowledge of many of the groups on which they are reporting.

larger than those obtained by the 'Porcupine,' one of the cirri having 56 joints. One individual may have had but 10 arms; a second had 11 and perhaps more; but most of them are broken at the base, only one distichal series of two joints being left. The third had 14 arms or more, one bidistichate and three tridistichate series remaining; and of the six arms following these tridistichate series, three have the first pair of brachials united by syzygy ( $A. 3. \frac{b}{2}$ ), while in the other three there is a syzygy in the second brachial ( $A. 3. 2b$ ). We thus meet with a remarkable approximation to the characters of *Antedon multispina* and *A. porrecta*, which were obtained by the 'Challenger' near Tristan D'Acunha and Ascension, in depths of 550 and 420 fathoms respectively. The former type, like *Antedon lusitanica*, may sometimes have no more than ten arms, as in the six 'Challenger' specimens from Ascension; while the single individual from Tristan D'Acunha possesses one bidistichate and two tridistichate series, two of the arms borne on the latter having a syzygial union between the first two brachials, while the other two are of the ordinary type, with a syzygy in the third brachial. It is, of course, possible that tridistichate series may have existed in the other individuals of *Antedon lusitanica*, which have the arms broken at the syzygy in the third joint above the costal axillary; for there is now no means of deciding whether the epizygal of this syzygy was an axillary or a simple brachial. It is therefore not absolutely certain whether there are any ten-armed individuals of *A. lusitanica* at all, as seemed to be the case at first, before any tridistichate forms were known; and it is worth notice that in this one individual we meet with the characters of one ten-armed and three multibrachiate types of Comatulæ ( $A. 2.—A. 3. \frac{b}{2}—A. 3. 2b$ ), two of the latter being the same as occur in the single example of *A. multispina* from Tristan D'Acunha.

Should the tridistichate condition eventually prove to be common in these two species, it may become necessary to unite them under one name. At present, the main points of difference between them, apart from the characters of the arm-divisions, appear to lie in the longer cirri and less spinous arms of *A. lusitanica*, in which also the joints of the genital pinnules, as the Madeira specimens show, are somewhat produced upwards

on the outer side, as is so markedly the case in *Antedon basicurva*; but there is nothing of this kind in *A. multispina*.

3. *ANTEDON PHALANGIUM*, Müller, sp. (See the Report on the Comatulæ, Zool. Chall. Exp. vol. xxvi. 1888, p. 158, pl. xxviii. figs. 1-3.)

Mr. Johnson has sent me three examples of this species.

1. From the Telegraph-cable in Funchal Bay, at a depth of about 100 fathoms. Excepting for the extreme shortness of the later cirrus-joints, this is generally similar to the specimens obtained by the 'Dacia,' in 88 fathoms, on the Seine bank, between Madeira and the coast of Morocco.

This individual presents a curious instance of monstrosity. The position of the normal pinnule on the sixth brachial of one of its arms is occupied by a small axillary joint, which bears two pinnules of the usual character; while a third pinnule is attached to the distal edge of the arm-joint, on the dorsal side of the axillary.

2. From the Brazilian Cable, 500-700 fathoms. Two specimens.

One of these two individuals is fairly normal in its characters, with relatively narrow rounded rays which stand out well from the calyx, and do not come into lateral contact. But the other is somewhat remarkable; for it resembles many of the deep-sea Comatulæ which belong to the *Basicurva*-group, in the lateral approximation of its rays and the flattening of the outer sides of its first two brachials. I have noticed this feature in other examples of the type from shallower water, but have never seen it so marked as in this specimen, the discovery of which at 500-700 fathoms more than doubles the bathymetrical range of the type; and it is very interesting to find this increase of range associated with a peculiarity which is chiefly characteristic of the Comatulæ found in the abyssal zone; though its absence in the other individual from the same depth is a little puzzling. In fact, these two examples represent two very different varieties of the species. The distal edges of the arms and pinnules of the second specimen are fringed with rather large spines, a peculiarity which I have not noticed in any examples of the type obtained in other localities.

4. *Antedon Dübeneri*, Böhlische. (See the Report on the Comatulæ, Zool. Chall. Exp. vol. xxvi. 1888, p. 181, pl. xxxvii. figs. 1-3.)

The original of this species was obtained at Rio Janeiro, and another example was dredged by the 'Challenger' at Bahia. Some specimens from Madeira, kindly given to me by Professor Lovén, prove to belong to the same type; and Mr. Johnson has sent me others "from deep water, attached to corals and masses of *Ostræa* shells," in the same locality. Greeff's examples from the Canaries and from the Equatorial Island, Rolas, in the Gulf of Guinea\*, are doubtless of the same nature. They have been described as *Antedon rosacea*, and I find some difficulty in differentiating the Madeira specimens among the many forms of this protean species. One of the chief characters of Böhlische's type is the presence of a minute plate between the first costals (second radials, *auct.*). But this intercostal plate is not well marked in the 'Challenger' specimens of *A. Dübeneri*, though it reappears in all those from Madeira, in which also the first two brachials have sharp and straight outer edges. The latter feature, however, is very characteristic of the Naples variety of *Antedon rosacea*, in which, too, the intercostal plate sometimes appears, while both peculiarities occur in examples of this type from Ilfracombe, Milford Haven, the Shetlands, and the Faroe Channel. I have much doubt, therefore, as to *Antedon Dübeneri* being a good species. The Madeira specimens are unquestionably identical with those from Brazil, and this is a point of some importance, as it adds another to the species of Crinoids which occur on both sides of the Atlantic†. But I find a great difficulty in making up my mind as to whether the numerous varieties of *Antedon rosacea* ranging from the Faroe Channel to Madeira, or even further, should all be referred to one species. It seems to be even more variable than *Antedon carinata* and *Actinometra parvicirra*, which is saying a good deal; but I am inclined to think that further study will confirm my present impression that all these forms represent but one specific type, to which the following names have been applied at different times:—

\* "Echinodermen, beobachtet auf einer Reise nach der Guinea-Insel São Thomé," Zool. Anzeiger, 1882, V. Jahrg. pp. 116, 159.

† These are *Rhizocrinus lafotensis*, *R. Rawsoni*, *Antedon Eschrichti*, *A. quadrata*, *A. tenella*, *A. carinata*, *Actinometra pulchella*; and also *Antedon proliza*, if the Arctic species be included.



*adeonæ*, Della Chiaje.  
*annulata*, Risso.  
*barbata*, Linck.  
*bicolor*, Della Chiaje.  
*bifida*, Pennant.  
*coralina*, Risso.  
*decacnemus*, Pennant.  
*decameros*, Gray.  
*Dübeni*, Böhlische.  
*europæa*, Leach.

*fimbriata*, Barrelier.  
*fimbriata*, Dujardin (*non* Lamarck).  
*fimbriata*, Miller.  
*gorgonia*?, Fréminville.  
*mediterranea*, Lamarck.  
*milleri*, Müller.  
*pectinata*, Linnæus (*non* Retzius).  
*petasus*, Düben & Koren.  
*rosacca*, Linck.

On a Hermaphrodite Trout, *Salmo fario*.

By Prof. CHARLES STEWART, Pres. Linn. Soc.

[Read 19th February, 1891.]

(PLATE III.)

FOR the opportunity of examining and describing this exceedingly remarkable, if not unique, specimen, I am indebted to the kindness of Mr. Thos. Andrews, of Westgate House, Guildford, who has presented it to the Museum of the Royal College of Surgeons.

The specimen is a well-nourished example of the Common Trout (*Salmo fario*). It is 300 millim. in length; and I am informed by Mr. Andrews that on two occasions ripe ova were, by artificial pressure, extruded from its belly; and these eggs, although kept completely isolated, on both occasions developed normal young.

The fish, when received by me, had been kept for some time in strong spirits, which had made the body rigid in a bent position. The abdomen also had been opened, and a partial examination made.

In the body-cavity were between two and three dozen loose ova; these had apparently escaped from a rupture in the posterior extremity of the right genital gland (ovary), or from near the posterior end of the right genital duct, which appeared to be either ruptured or defective at this point.

The genital glands were both loosely attached by a fold of peritoneum, which commenced at the extreme anterior end of the body-cavity, and extended along the outer borders of the swimming-bladder.

The right genital gland, 47 millim. in length, appeared to be of entirely ovarian nature, and contained many large ova which protruded from its surface. The posterior extremity of the gland was ruptured, but whether before death or from subsequent handling I am unable to say.

The right duct, 73 millim. long, is a delicate tube attached to the ventral wall of the swimming-bladder, and extending from the posterior end of the gland to its termination in the uro-genital chamber; there were three ova lodged in the duct at the latter point; and a short distance in front the duct was ruptured.

The left genital gland is 59 millim. in length. At 26 millim. from its anterior extremity the ovarian structure is replaced by testicular, this testis region being 16 millim. long and 5 millim. broad; it is abruptly defined by a constriction from the ovarian region in front, but posteriorly expands into the second portion of the ovary. The form of the testis is roughly that of a three-sided prism with a shallow groove in the middle of its ventral face.

The left duct is similar to the right, but is unruptured; they open side by side in the anterior wall of the uro-genital chamber.

There are two special points of interest in this case. Firstly, that from self-fertilized eggs healthy and normal young were reared; secondly, that this fish was fundamentally a male (as evidenced by the possession of genital ducts), the greater part of whose genital glands had acquired an ovarian structure. It is also, so far as I am aware, the first instance recorded of the occurrence of hermaphroditism amongst the Salmonidæ.

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On a Hermaphrodite Mackerel, *Scomber Scomber*.

By Prof. CHARLES STEWART, Pres. Linn. Soc.

[Read 4th June, 1891.]

(PLATE III.)

MR. W. B. TEGETMEIER has recently presented to the Museum of the Royal College of Surgeons a hermaphrodite Mackerel; and as there are very few cases on record, and this specimen has some unusual features, I have thought it desirable to give a brief account of it. The fish was 400 millim. long, and was received by

me in a perfectly fresh state; but as it had been cleaned by the fishmonger, its girth could not be determined. The genital organs had been detached from the dorsal wall of the body-cavity, but were still connected with the uro-genital pore.

The right ovary is full of well-developed ova. It is 150 millim. in length; in front it has a rounded commencement with a diameter of 27 millim., and from this point gradually tapers to the posterior extremity. Along the whole length of the dorsal border of the ovary extends a testis which somewhat exceeds the ovary in bulk; it slightly overlaps the outer surface of the ovary, and still more so the inner; the posterior portion of the inner surface of the ovary for a distance of 15 millim. has the testicular structure, and is directly continuous with the general body of the testis above. In front the testis projects 16 millim. beyond the ovary, and has to its inner side a bilobed mass of testis in contact, but apparently not continuous, with the main body.

The left ovary is 134 millim. long. In front it has about the same diameter as the right; but this diameter is retained until about 40 millim. from the posterior extremity, when it begins to taper. The natural bulk of the left ovary somewhat exceeds the right.

The whole length of the dorsal border of the left ovary, with the exception of 15 millim. at its exterior extremity, gives attachment to a testis which overlaps the outer surface of the ovary for about half its diameter.

The extreme tip of the ovary is capped with a cocked-hat-shaped testis-mass having 14 millim. basal diameter. Dorsally halfway between the main body of the testis and the above-mentioned lobe is a small patch of testicular tissue flush with the general surface of the ovary.

Both ova and spermatozoa were perfectly developed, and the ovaries and testes of approximately equal size.

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Catalogue of the described Hemiptera Heteroptera and Homoptera of Ceylon, based on the Collection formed (chiefly at Pundaloya) by Mr. E. Ernest Green. By W. F. KIRBY, F.L.S., F.E.S., Assistant in Zoological Department, British Museum (Natural History), S. Kensington, S.W.

[Read 19th March, 1891.]

(PLATES IV.-VI.)

DURING the residence of Mr. E. Ernest Green in Ceylon, he formed a large collection of insects of all Orders, part of which, including a fine series of Hemiptera Heteroptera and Homoptera, he has liberally presented to the British Museum. Most of these were obtained at Pundaloya, in the hill-country; but some, more especially among the aquatic species, are from Nitagala, in the north central part of the island, and a few are from Nawalapitya, Kandy, Colombo, and other places. Where no locality is mentioned in the following pages, it may always be inferred that the insect is from Pundaloya, unless the habitat is indicated as doubtful.

Mr. Green's collection proved to contain so large a proportion of the species already known from the island, that I thought it would be rendering a real service to science to publish a complete list, adding descriptions of most of the new ones. Such lists of species from a restricted locality are of great value, as they form a more satisfactory basis for future work than in the case of more extensive Faunas.

Nearly all the larger species already known from Ceylon are represented in Mr. Green's collection; but although he obtained a fair number of the smaller species likewise, yet, as these must be extremely numerous in Ceylon, and the few which have been described were mostly obtained from localities different from those where Mr. Green collected, it is perhaps not surprising that his collection not only contained a much larger number of new species among the smaller species than among the larger (which might reasonably have been expected in any case), but that comparatively few of the smaller species which have already been described could be found among his specimens. However, I was glad to find representatives of the interesting genera *Macropes* and *Ossa* of Motschulsky.

I have not ventured to describe the whole of the smaller species obtained by Mr. Green. In some cases it would be desirable to compare them with other species which have already been

described, but which are not at present in our collection. In others, the insects appear to belong to genera different from any with which I could compare them; and so large a number of new genera have been proposed of late years, both in Heteroptera and Homoptera, that it would be very unwise to create new genera wholesale, until those already proposed have undergone a thorough and much-needed revision, which at present I have no time to attempt. I have, however, been obliged to propose a few new genera myself in the present paper; and I wish to call special attention to two extraordinary new forms among the Reduviidæ, *Dicephalus* and *Formicoris*. In *Dicephalus* the head and thorax are segmented in such a manner as hardly to give it the appearance of a genuine insect; and the position of the ocelli on the front of the hinder lobe of the head is also very remarkable. *Formicoris*, on the other hand, is the exact counterpart of a black spiny ant of the genus *Hoplomyrmus*, Gerst. (|| *Polyrhachis*, Smith); and no one who did not notice its structure would imagine it to be anything else.

Too little is known of the Hemipterous and Homopterous Faunæ of the countries nearest to Ceylon to allow the relations of the Cinghalese Fauna to be discussed in the present paper. We may regard it as likely that many of the Cinghalese species will prove to be peculiar to the island, and that many of the smaller ones especially will prove to be confined to very restricted localities.

Much, no doubt, remains to be done before even the larger species which inhabit Ceylon can be regarded as approximately known, while it may reasonably be expected that the smaller species will eventually be estimated by thousands rather than by hundreds. I will now proceed to give a brief sketch of what has already been done to systematize our knowledge of the Hemiptera of the island.

The first list was published by Walker in Tennent's 'Ceylon' (vol. i. pp. 292–293, 2nd edit. 1859), and includes only 42 Heteroptera and as many Homoptera. But although Walker was, in general, a very good bibliographer, this list was probably compiled in haste, for it is extremely unsatisfactory, and is very far from including all the species which had been described from Ceylon at the time. Many of the names are MS., representing species which Walker intended subsequently to describe, but did not, and which cannot now be always identified with certainty; and a few appear to have been erroneously recorded from Ceylon.

This list was reprinted, almost verbatim in 1863, by Motschulsky (Bull. Soc. Imp. Nat. Moscou, xxxvi. (3) pp. 74-115), who added descriptions of 28 new Hemiptera and 28 new Homoptera, besides giving references to 3 more Hemiptera and 10 Homoptera published by himself in his 'Études Entomologiques,' viii. (1859), pp. 108-115. He makes scarcely any other additions to Walker's list; but the localities of his own new species are, in most cases, carefully indicated.

A much better list of the Hemiptera Heteroptera of Ceylon was, however, published by Anton Dohrn in 1860 in the Stett. ent. Zeit. xxi. pp. 399-409. He enumerates 112 species, of which 39 are described as new. However, this list likewise contained a number of MS. species.

In the present paper, which I believe may be regarded as fairly complete, I have raised the number of described Cinghalese species of Hemiptera Heteroptera to 285 (38 new), and of Homoptera to 187 (59 new).<sup>\*</sup> In accordance with my usual practice in faunistic papers, I have abstained from describing many new genera, and I avoid long descriptions, as far as possible. The species are grouped under the more important families, smaller subdivisions being omitted.

All the species in the following list of which the British Museum possesses specimens from Ceylon are marked (\*), and all those contained in Mr. Green's collection are marked (†). Some of the latter had been labelled, and one or two described, by the late Mr. Atkinson. I am indebted to Mr. Green for information respecting the habits, localities, &c. of several species; and these paragraphs are marked with his initials.

## HEMIPTERA HETEROPTERA.

### PENTATOMIDÆ.

#### \*†CANTAO OCELLATUS.

*Cimex ocellatus*, *Thunb. Nov. Spec. Ins.* p. 60, f. 72 (1783).

A very common and variable species throughout the Indo-Malayan region. It is gregarious, and often found in numbers (20 or 30 together) collected on a single branch of a tree (*E. E. G.*).

\* It will be noticed that two or three of these species have been recorded from Ceylon on somewhat doubtful authority, and their actual occurrence in the island requires confirmation.

## √ \*†CALLIDEA PERPLEXA.

*Tectocoris perplexa*, Hope, *Cat. Hemipt.* p. 4, n. 11 (1837).

*Cimex nobilis*, Sultz. (*nec* Linn.) *Gesch. Ins.* pl. xi. f. c (1776).

*Cimex nobilis*, pt., Fabr. *Sp. Ins.* ii. p. 338, n. 2 (1781).

Mr. Green's specimens are labelled "Putlam."

A very common species in India and Ceylon, and it likewise occurs in Burmah and Siam. Many of the older authors mention Java as the locality; but this probably arose from its being usually mistaken for *Cimex nobilis*, Linn., which is a common species in Java, China, &c., but apparently not found in India proper.

Hope appears to have been the first author who discriminated between the two species; but as they are now placed in different genera, most recent authors have retained the specific name *nobilis* for both, calling one *nobilis*, Linn., and the other *nobilis*, Fabr., which does not appear to be quite correct.

The Cinghalese specimens are of an emerald-green, rarely inclining to violet-blue on the pronotum and at the base of the scutellum, and never with the green of the whole insect replaced by violet, but frequently with a strong coppery lustre over the pronotum and a great part of the scutellum. The normal spotting is as follows:—Two blue-black spots on the pronotum and five on each side of the scutellum, three near the median line, and two near the margins; but all these spots are variously developed in different specimens, and are not unfrequently entirely obsolete. I believe these variations to be merely colour-varieties of one species.

## √ \*†CALLIDEA ERICHSONI.

*Callidea Erichsoni*, Germ. *Zeitschr. Ent.* i. p. 113 (1839).

Usually confounded in collections with *C. Stockerus*, Linn., which does not appear to occur in Ceylon. In some specimens the black stripe at the tip of the scutellum is obsolete.

This species is found swarming on trees (*Phyllanthus*, sp.) and sucking the berries (*E. E. G.*).

## √ \*†CALLIDEA BENGALENSIS.

*Callidea bengalensis*, Hope, *Cat. Hem.* p. 15 (1837).

Two specimens of this common Indian species are in Mr. Green's collection. One of these was labelled "*Chrysocoris patricia*, Fabr." ‡ and Dohrn doubtless refers to the same species under

‡ *Cimex patricius*, Fabr. *Suppl. Ent. Syst.* p. 527 (1798).

the name of "*Callidea patricia*;" but I am not convinced of the correctness of the identification.

✓ \*†*CALLIDEA SUPERBA*.

*Callidea superba*, *Dall. List Hem. Ins. B.M. i. p. 23, n. 6* (1851).

Described from Ceylon. The specimen from Amboina recorded by Walker is quite distinct from *C. superba*, being very differently punctured.

./ \**CALLIDEA SPILOGASTRA*.

*Callidea spilogastra*, *Walk. Cat. Het. Hem. B. M. i. p. 30, n. 22* (1867).

Described from Ceylon (Thwaites' Collection).

\*†*CALLIDEA RAMA*, sp. n. (Plate IV. fig. 3.)

Long. corp. 13–15 millim.

*Upperside*. Emerald-green, slightly glossed with blue towards the edges and with coppery in the middle, but only in certain lights; and with large blue-black markings. Head with two deep longitudinal furrows, subparallel, but slightly narrowed beyond the middle in front, entirely blue-black, except a slight green line on each side at the extremity, where the frontal ocellus stands; ocelli red; antennæ black.

Thorax thickly punctured; but the punctuation is variable, and in the middle of the pronotum and sometimes of the mesonotum is hardly perceptible. Pronotum with three large transverse blue-black spots, the outer ones oval, the middle one more irregular, and sometimes connected by a broad band intersected by a green line with the double central mark on the mesonotum. Mesonotum with two broad longitudinal stripes in the middle, more or less connected, being only partly separated by a central green line; on each side of these is a longitudinal band, sometimes broken into two spots; and the lateral tubercles also stand on blue-black spots. Scutellum with two curved transverse bands at the base, nearly connected, a large hastate spot in the middle, two large spots on each side, and a large trapezoidal spot before the extremity. The exposed portion of the wings is blue-black.

Under surface much more strongly punctured towards the sides; head beneath green, punctured, antennæ and a central stripe black, proboscis red, lower mouth-parts of a tawny yellow; sternum green, coxæ and trochanters sometimes marked with tawny yellow, femora red nearly to the knees; knees and tibiae green above, blackish beneath; tarsi blue-black. Abdomen



beneath mostly tawny yellow, the middle of the basal segments black; a magenta-coloured stripe above the spiracles, which are blue-black, and form the upper side of an oval, which is directed forwards, and is green in the middle and blue-black at each extremity; terminal segments black, spotted with green on the sides.

A very handsome species, allied to *C. superba*, Dall., but smaller and differently coloured.

Pundaloya.

#### HOTEA CURCULIONIDES.

*Pachycoris curculionides*, Herr.-Schäff. *Wanz. Ins.* iii. p. 106, pl. cvii. f. 331 (1836).

Abundant throughout the Indo-Malayan and a great part of the Austro-Malayan Region, and recorded from Ceylon by Dohrn.

\* (?) *TRIGONOSOMA CONFUSUM*, sp. n.

Long. corp. 11 millim.

Leather-coloured above, thickly punctured, a yellow line visible from one shoulder-projection to the other (in front of which the thorax and head fall away perpendicularly), and also round the projecting rim of the abdomen, which extends just beyond the scutellum. Head and front of thorax paler than the upper part, the front of the thorax thickly marked with black punctures, which are crowded together in such a way as to give the appearance of irregular transverse mottling. Thorax above with large obtuse lateral angles, projecting slightly forwards and outwards; on the hinder border of the thorax is a black stripe, not extending to the sides, but throwing out four square projections in front. Scutellum unspotted, but with a shallow bowl-shaped space at the base lighter than the rest. Under surface tawny brown, mottled with darker, especially on the sternum; legs paler tawny, unspotted; antennæ wanting. (N.B. The measurement given is from the crest of the thorax.)

Described from a specimen presented to the British Museum by a Mr. Paul in 1849. Some of his insects (including the few Hemiptera) are said to have come from Ceylon, and others from Egypt. The present specimen was referred by Dallas to *T. Desfontainei*, Fabr., and by Walker to *T. Fischeri*, Herr.-Schäff. (of which *T. Baerensprungi*, Stål, is regarded as a synonym); but it does not agree well with the descriptions of any

of these insects. It is, however, very similar to *T. falcatum*, Cyr., for which Walker gives the localities "S. France, Sicily, Ceylon;" while the British Museum contains specimens from Egypt and Trebizond. I should not be surprised to find that the present species was really from Egypt, and not from Ceylon; and possibly Walker may have originally regarded it as *T. falcatum* (of which it might almost be a dark variety) before he identified it as *T. Fischeri*; and consequently noted Ceylon as a locality for *T. falcatum*. The occurrence of the genus in Ceylon still requires confirmation.

PODOPS OBSCURUS.

*Podops obscurus*, *Dall. List Hem. B. M. i. p. 52* (1851).

Noted by Walker as found in Ceylon; but this requires confirmation. The type is from Tenasserim.

\*†COPTOSOMA SPHÆRULA.

*Thyreocoris sphærula*, *Germ. Zeitschr. Ent. i. p. 25, n. 2* (1839).

*Coptosoma ellia*, *Walk. Cat. Het. Hem. B. M. i. p. 87, n. 32* (1867).

||*Coptosoma ceylonica*, *Motsch. Bull. Mosc. xxxvi. (3) p. 74* (1863).

*Coptosoma minima*, *Atk. Journ. As. Soc. Beng. lvii. p. 342* (1889).

*Nura Ellia* (*Motschulsky*); *Pundaloya* (*Green*).

Originally described from Java, but equally common in India, China, and Ceylon.

\*COPTOSOMA LATICEPS.

*Coptosoma laticeps*, *Dall. List Hem. Ins. B. M. i. p. 68* (1851).

Described from Ceylon (Gardner's collection).

\*†COPTOSOMA BRUNNEUM.

*Coptosoma brunnea*, *Atk. J. A. S. B. lvii. p. 342* (1889).

Closely allied to *C. laticeps*, and perhaps not truly distinct; but in all Mr. Green's specimens of *C. brunneum* the front of the thorax is transversely darker than the rest, and more or less completely defined from it by the surrounding paler markings.

\*†COPTOSOMA CEYLONICUM.

*Coptosoma ceylonicum*, *Dohrn, Stett. ent. Zeit. xxi. p. 399* (1860).

The single specimen obtained by Mr. Green does not quite agree with Dohrn's description, but is probably a mere variety.

\*†COPTOSOMA CRIBRARIUM.

*Cimex cribrarius*, *Fabr. Suppl. Ent. Syst. p. 531* (1798).

Mr. Green's specimen is labelled "Putlam." A common East-Indian species.

## \*†COPTOSOMA NOBILE.

*Coptosoma nobile*, *Dohrn, Stett. ent. Zeit.* xxi. p. 400 (1860).

Described from Ceylon.

## COPTOSOMA ATOMARIUM.

*Thyreocoris atomarium*, *Germ. Zeitschr. Ent.* i. p. 27, n. 6 (1839).

Recorded from Java, the Philippines, and Ceylon (Dohrn's list), but apparently not a very common species.

## TROPIDOSTYLUS FASCIOLATUS.

*Tropidostylus fasciolatus*, *Stål, Svensk. Handl.* (2) xiv. (4) p. 15 (1876).

Described from Ceylon. A single immature specimen in Mr. Green's collection possibly belongs to this species.

## \*†BRACHYPLATYS SILPHOIDES.

*Cimex silphoides*, *Fabr. Ent. Syst.* iv. p. 86, n. 24 (1794).

*Brachyplatys cingalensis*, *Stål, Öfv. Vet.-Akad. Förh.* xii. p. 181 (1855), xiii. p. 54 (1856).

A common species in the East Indies. The measurements given by Stål slightly exceed those of the specimens before me; but I have little doubt of the correctness of the identification.

## \*†BRACHYPLATYS SUBÆNEA.

*Plataspis subænea*, *Hope, Cat.* p. 17 (1817).

*Thyreocoris septus*, *Germ. Zeitschr.* i. p. 32, n. 19 (1839).

Common in the East Indies.

## BRACHYPLATYS VAHLII.

*Cimex VahlII*, *Fabr. Ent. Syst.* iv. p. 89, n. 41 (1794).

Included in Dohrn's list as Cinghalese. I have not seen a specimen from Ceylon, as that mentioned by Walker really belongs to *B. subænea*.

## \*†CANTHECONA INSULARIS, sp. n. (Plate IV. fig. 4.)

Long. corp. 15 millim.

Testaceous, covered above and below with reddish-brown punctures; abdomen with the dorsal surface dark reddish brown, shading into blackish at the extremity, the sides rufo-testaceous, ventral surface testaceous, slightly varied with black on the sides and terminal segment, and with a black spot on the middle of the penultimate segment; legs slightly hairy, femora more or less

reddish, and front femora with a rather strong spine about the middle; membrane fusco-hyaline, with a hyaline space on the costa before the tip, and another on the hind margin; thoracic spines black, nearly straight in front and emarginate behind, giving them a sub-bifid appearance. Antennæ rufo-testaceous, slightly darker towards the extremity.

Allied to the Indian *C. furcillata*, Wolff; but that species has the upper surface and the antennæ varied with black, and the thoracic spines are more slender and distinctly directed forwards.

\*† *ASOPUS MACTANS*.

*Cimex mactans*, *Fabr. Spec. Ins.* ii. p. 366, n. 168 (1781).

Two specimens of this well-known and variable East-Indian species from Kandy have much more extensive dark markings above than any of those before me from other localities. One of these has a curved black line, depressed in the middle, bending from one of the inner angles of the prothorax to the other; and the other specimen has two bands on the tegmina, one forming a long triangle covering nearly the whole of the inner half of the tegmina, and the other above the hinder part of the first, forming a thick line pointed at each end.

*ÆTHUS OBLONGUS*.

*Cydnus oblongus*, *Ramb. Faune de l'Andalusie*, ii. p. 115 (1842?).

A South-European species, included in Dohrn's list as Cinghalese.

*ÆTHUS SCUTELLATUS*.

*Æthus scutellatus*, *Dohrn, Stett. ent. Zeit.* xxi. p. 400 (1860).

Described from Ceylon.

\*† *ÆTHUS CEYLONICUS*.

*Æthus ceylonicus*, *Mayr, Reise d. Novara, Hem.* p. 9 (1866).

*Æthus nigroæneus*, *Walk. Cat. Het. Hem. B. M.* i. p. 158 (1867).

Marked "Putlam" in Mr. Green's collection.

\*† *ÆTHUS VARIANS*.

*Cimex varians*, *Fabr. Syst. Rhyng.* p. 187, n. 16 (1803).

*Æthus cyrtomenoides*, *Dohn. Stett. ent. Zeit.* xxi. p. 400 (1860), teste Signoret.

Seems to be common in Ceylon.

\**ÆTHUS MAURUS*.

*Æthus maurus*, *Dall. List Hem. Ins. B. M.* i. p. 118, n. 18 (1851).

A specimen of this common East-Indian species is recorded by Walker from Ceylon, from Cuming's collection.

Differs from *Æ. varians* in having only the tarsi ferruginous.

\**ÆTHUS OMICRON*.

*Æthus omicron*, *Walk. Cat. Het. Hem. B. M.* iii. p. 534 (1868).

Described from Ceylon (*Thwaites*).

Closely allied to *Æ. maurus*, but rather smaller.

\**ÆTHUS BADIUS*.

*Æthus badius*, *Walk. Cat. Het. Hem. B. M.* i. p. 159, n. 73 (1867).

One specimen from Ceylon in the British Museum, collected by Dr. Thwaites. Also occurs in India and China.

\**ÆTHUS APICALIS*.

*Æthus apicalis*, *Dall. List Hem. Ins. B. M.* i. p. 120, n. 20 (1851).

A common Indian species.

*ÆTHUS* (?) *MINUTUS*.

*Cydnus* (?) *minutus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 75 (1863).

Described from Ceylon (Colombo and Mount Patannas).

\*†*AGONOSCELIS NUBILIS*.

*Cimex nubilis*, *Fabr. Syst. Ent.* p. 712, n. 74 (1775).

A common East-Indian species ; but the type specimen is said (probably erroneously) to have come from the Cape.

\**ERTHESINA FULLO*.

*Cimex Fullo*, *Thunb. Nov. Spec. Ins.* p. 42, pl. ii. f. 57 (1783).

*Erthesina fullo*, *Atk. J. A. S. B.* lvii. p. 5 (1888).

This species is very common, and very widely distributed throughout Eastern Asia ; it is usually confounded with the next.

\*†*ERTHESINA GUTTATA*.

*Cimex guttatus*, *Fabr. Mant. Ins.* ii. p. 291, n. 121 (1787).

*Erthesina guttata*, *Atk. J. A. S. B.* lvii. p. 6 (1888).

The localities given by Atkinson are India, Siam, and Ceylon ; Mr. Green's specimens are from Kandy.

\*†*HALYS DENTATA*.

*Cimex dentatus*, *Fabr. Syst. Ent.* p. 702, n. 28 (1775).

A very common Indian species. Mr. Green's specimens are from Mataratta.

## \*†MORMIDEA FLORENS.

*Mormidea florens*, *Walk. Cat. Het. Hem. B. M.* ii. p. 263, n. 62 (1867).

A well-known and rather variable East-Indian species. Mr. Green's collection contains a specimen from Pundaloya, with a reddish-tawny stripe running across the front of the thorax from the tip of one projection to the tip of the other. The projecting angles beneath are of the same colour, edged outside with black. The round spot at the end of the scutellum is of a distinctly greenish white. Without a larger series from various localities, it is impossible to determine whether this Cinghalese form should be regarded as a species or not.

## \*†MORMIDEA SIMILIS, sp. n.

Long. corp. 8 millim. ; lat. 5 millim.

Greenish olive, with large punctures ; antennæ and legs paler ; shoulder-angles broad, moderately long and pointed ; thorax with a transverse, smooth, black depression at the extremity ; basal angles of the scutellum with large ivory-white smooth spots, between which a pale pear-shaped mark, punctured with black, rises from a semicircular ivory-white mark with only a few punctures, at the tip of the scutellum ; tegmina with a reddish shade, most distinctly seen as an oblique red streak, less strongly punctured than the rest ; projecting part of the corium hyaline.

Under surface paler than above and much less strongly punctured, with scattered black spots.

Closely allied to the Indian *M. socia*, Walk., but in that species there is no red shade on the tegmina, the scutellar spots are much less sharply defined, and the under surface is marked with smaller and more regular dots. In *M. contigua*, Walk., from Java, the reddish shade extends over the greater part of the tegmina, and the shoulder-angles are longer and more acute.

The type is labelled "Putlam."

## \*† (?) ÆSCHRUS OBSCURUS.

*Æschrus obscurus*, *Dallas, List Hem. Ins. B. M.* i. p. 221, n. 1 (1851).

A somewhat rare species, recorded from India and Java. An immature specimen in Mr. Green's collection, without special locality, seems to be referable to this insect.

*EYSARCORIS DUBIUS.*

*Eysarcoris dubius*, *Dall. List Hem. Ins. B. M.* i. p. 227, n. 7 (1851); *Atk. J. A. S. B.* lvii. p. 40 (1888).

Described from Tenasserim. Dohrn mentions a supposed variety from Ceylon.

\*†*EYSARCORIS GUTTIGERUS.*

*Cimex guttigerus*, *Thunb. Nov. Spec. Ins.* p. 32, pl. ii. f. 47 (1783).

Common in China and India. Mr. Green's specimens are labelled "Putlam."

\*†*ANTESTIA CONCINNA.*

*Rhaphigaster concinna*, *Dall. List Hem. Ins. B. M.* i. p. 285 (1851).

Two specimens in Mr. Green's collection, one reddish and the other greenish olive.

\*†*ANTESTIA PUNCTATISSIMA*, sp. n.

Long. corp. 7 millim.; lat. 4 millim.

Testaceous, thickly covered with black punctures arranged more or less in lines; head above with two black median lines, slightly diverging in front, two others on each side, meeting at half the length to form a single thicker stripe on each side in front, and another short black stripe beneath each eye; pronotum with the angles not very prominent and with the punctures arranged in irregular transverse lines; scutellum with the centre irregularly punctured, the margins more thickly and regularly, and the apex with a large impunctate, smooth, bone-coloured spot. Corium with the punctures most linear towards the borders, and a nearly impunctate space close to the extremity near the costa, and another on the inner margin, between which is a black spot, about the middle, from which a dusky space, shaded with reddish, extends to the inner margin. Under surface rufo-testaceous; the front half and hind border of the pectus, and the sides of the pectus and abdomen, thickly punctured with black; the thoracic angles and the extremities of the sutures of the abdomen are distinctly spotted with black.

In Mr. Green's collection, without special locality. Allied to *A. quadrimaculata*, Walk., from Celebes.

\*†*HALYOMORPHA PICEUS.*

*Cimex piceus*, *Fabr. Syst. Rhyng.* iv. p. 115, n. 138 (1794).

*Halyomorpha picus*, *Atk. J. A. S. B.* lvii. p. 23 (1888).

*Halys timorensis*, *Hope, Cat.* p. 22 (1837).

*Pentatoma trivialis*, *Dohrn, Stett. ent. Zeit.* xxi. p. 400, n. 22 (1860).

Common in the East Indies, and rather variable in colour. A long list of synonyms is given by Atkinson (*l. c.*).

Mr. Green's specimens are from Pundaloya and Nawalapitya.

\*†PENTATOMA CONTINGENS.

*Pentatoma contingens*, *Walk. Cat. Het. Hem. B. M.* ii. p. 302, n. 121 (1867).

The type is from Hong Kong. This insect is perhaps a variety of *P. gutta*; Dall., likewise a Chinese species.

Mr. Green's Cinghalese specimens are rather variable, and in the darkest specimens the pale spot at the tip of the scutellum has entirely disappeared. They are labelled "Putlam."

\*†PENTATOMA TAPROBANENSIS. (Plate IV. fig. 1.)

*Pentatoma taprobanensis*, *Dall. List Hem. Ins. B. M.* i. p. 244, n. 27 (1851).

A very distinct and well-marked insect, common in Ceylon.

Gregarious; found on the bark and trunks of orange-trees (*E. E. G.*).

PENTATOMA LEMUR.

*Pentatoma lemur*, *Dohrn, Stett. ent. Zeit.* xxi. p. 401, n. 25 (1860).

Described from Ceylon.

\*†PENTATOMA (?) CORINNA, sp. n. (Plate IV. fig. 12.)

Long. corp. 11 lin.; lat. 7 lin.

Brown, thickly covered with darker punctures; head rather long, with two central grooves, front bifid; pronotum deeply emarginate before the lateral angles, rendering them nearly straight in front; they are prominent, moderately long, and slightly obtuse at the tips. Under surface paler, mottled and speckled all over with black; ventral surface of abdomen with obsolete blackish markings, and sometimes with a zigzag row of blackish markings on each side. Legs, especially femora, distinctly marked with black dots. Terminal segment of abdomen quadrid, the four projections rather pointed and of equal size. Antennæ slender, set with short bristles, 5-jointed; joints 3 and 4 of equal length, 2 shorter, and 4 shorter than 2.

Pundaloya.

This species hardly appears to belong to any genus represented in the British Museum; but so large a number of genera of *Pentatomidæ* have been proposed on slight characters that I am unwilling to add to their number until they have undergone thorough investigation.



## \*†STRACHIA FIMBRIATA.

*Cimex fimbriatus*, *Fabr. Mant. Ins.* ii. p. 295, n. 162 (1787).

Var. *Pentatoma crossota*, *Dall. List Hem. Ins. B. M.* i. p. 352, n. 49 (1851).

A common and wide-ranging East-Indian insect, in both forms.

## \*†STRACHIA CRUCIATA.

*Cimex cruciatus*, *Fabr. Ent. Syst.* iv. p. 119, n. 153 (1794).

*Strachia geometrica*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 75 (1863); *Nietn. Enemies of Coffee Tree*, p. 18 (1861).

*Strachia velata*, *Walk. Cat. Het. Hem. B. M.* ii. p. 329, n. 62 (1877).

*Strachia subacta*, *Walk. l. c.* n. 63 (1877).

Feeds on the berries of the coffee-tree (*E. E. G.*). A variable species; I think I am correct in placing the above names together.

Mr. Green's collection includes two specimens of a very pretty variety, with all the darker parts green, and the lighter ones indistinctly outlined in pale yellow. The tegmina are reddish, with the black markings present or absent, and the costa green.

## \*†STRACHIA PICTA.

*Cimex pictus*, *Fabr. Syst. Ent.* p. 715, n. 93 (1775).

A common Indian insect. Mr. Green's specimens are without special locality.

## \*†BATHYCELIA INDICA. (Plate IV. fig. 15.)

*Bathycoelia indica*, *Dall. List Hem. Ins. B. M.* i. p. 270, n. 3 (1851).

The type is from North India. Mr. Green's specimens are chiefly from Nawalapitya, but one is labelled "Putlam."

A most variable species; fawn-colour; buff spotted with green or dark blackish green. Easily recognizable by the curious black puncture at the basal angles of the scutellum. The closely allied African species *B. thalassina*, Herr.-Schäff., varies in colour in precisely the same manner.

## \*†CATACANTHUS INCARNATUS.

*Cimex incarnatus*, *Drury, Ill. Ex. Ent.* ii. pl. xxxvi. f. 5 (1773).

*Catacanthus incarnatus*, *Atk. J. A. S. B.* lvii. p. 71 (1888).

A common insect throughout the whole Indo-Malayan region, from the Corea to Borneo.

## \*†ZANGIS DORSALIS. (Plate IV. fig. 2.)

*Rhaphigaster dorsalis*, *Dohrn, Stett. ent. Zeit.* xxi. p. 401, n. 28 (1860).

*Zangis virginea*, Stål, *Vet. Akad. Handl.* (2) xiv. (4) p. 93 (1876).

A handsome species, perhaps peculiar to Ceylon.

Stål makes two species of this, but the three specimens before me agree equally well with Dohrn's description and with the points on which Stål separates his *Z. virginea*.

Frequently flies into the rooms at night, attracted by the light (*E. E. G.*).

\*†RHAPHIGASTER VIRIDULUS.

*Cimex viridulus*, Linn. *Syst. Nat.* i. p. 414, n. 28 (1758).

*Cimex prasinus*, Linn. *Faun. Suec.* p. 249 (1761).

Var. *Cimex torquatus*, Fabr. *Syst. Ent.* p. 710, n. 65 (1775).

Common in most parts of the Old World. Mr. Green's collection contained a specimen of the var. *torquatus*, with the front of the head and thorax bordered with dull orange.

Nawalapitya.

\*†RHAPHIGASTER REPELLENS, sp. n. (Plate IV. fig. 9.)

Long. corp. 11 lin. ; lat.  $6\frac{1}{2}$  lin.

Rather long and narrow ; very dark reddish brown above and reddish below ; legs and antennæ rufo-testaceous. Upper surface somewhat rugose and thickly punctured ; angles of the pronotum short, distinct, straight, pointed at the tip, but not very acutely, and the extreme point pale ; membrane fuscous or fusco-hyaline. Pectus thickly punctured ; ventral surface of abdomen much more finely ; subterminal segment of the abdomen with strong sharp lateral projections.

Pundaloya.

Not closely allied to any species in the Museum.

RHAPHIGASTER FLAVOLINEATUS.

*Rhaphigaster flavolineatus*, Hope, *Cat.* p. 31 (1837).

A widely-ranging species, included in Dohrn's list as Cinchalese.

\*†RHAPHIGASTER SORDIDA, sp. n.

Long. corp. 11 millim. ; lat. 7 millim.

Greenish testaceous, thickly covered with small brown or reddish-brown punctures over the whole of the upper surface and on the pectus ; scutellum reddish, a little greener on the sides before the extremity, which is rather broad and obtusely rounded ; a small black spot at the basal angles of the scutellum ; abdomen beneath with an irregular band of black blotches on each side of

the central line, meeting in a black blotch on the penultimate segment; there is also a zigzag series of narrower reddish or blackish submarginal markings; terminal segment ending in four pointed cones of nearly uniform size. Shoulder-angles not very prominent. Antennæ slender, unicolorous, as long as the width of the thorax.

*Pundaloya.*

Allied to *R. flavescens*, Walk., from an unknown locality; but this species is without distinct black markings on the under surface of the abdomen, and the terminal abdominal lobes are less regular.

\*† *TESSERATOMA PAPILLOSUM.*

*Cimex papillosus*, *Dru. Ill. Ex. Ent.* i. pl. xlii. f. 2 (1773).

Var. *Tesseratoma clara*, *Walk. Cat. Het. Hem. B. M.* iii. p. 404 (1868).

A common East-Indian species. Mr. Green's specimen is from Kandy.

*EUSTHENES CUPREUS.*

*Tesseratoma cuprea*, *Hope, Cat.* p. 27 (1837).

A common East-Indian species, noted by Walker as Cinghalese.

\* *MATTIPHUS ÆRUGINOSUS.*

*Mattiphus æruginosus*, *Stål, Trans. Ent. Soc. Lond.* (3) i. p. 600 (1863); *Atk. Journ. As. Soc. Beng.* lviii. p. 71 (1889).

A rare species in collections, and apparently confined to Ceylon.

\*† *PYCANUM PONDEROSUM.*

*Pycanum ponderosum*, *Stål, Æfv. Vet.-Akad. Förh.* x. p. 234 (1854), xiii. p. 63, pl. i. f. a (1856).

Recorded from India and Malacca. A single immature specimen from Kandy, probably belonging to this species.

\*† *CYCLOPelta SICCIFOLIA.*

*Aspongopus siccifolius*, *Hope, Cat. Hem.* p. 26 (1837); *Atk. J. A. S. B.* lviii. p. 89 (1889).

*Cyclopelta tartarea*, *Stål, Æfv. Vet.-Akad. Förh.* x. p. 234 (1854), xiii. p. 64 (1856).

A common Indian species. Mr. Green's specimens are from Kandy.

\*†*ASPONGOPUS JANUS*.

*Cimex janus*, *Fabr. Syst. Ent.* p. 714, n. 85 (1775).

*Aspongopus janus*, *Atk. J. A. S. B.* lviii. p. 88 (1889).

A common East-Indian species, originally described by Fabricius as American. Mr. Green's specimens are labelled "Torigan, Jan. 1890."

\**ASPONGOPUS OBSCURUS*.

*Cimex obscurus*, *Fabr. Ent. Syst.* iv. p. 107, n. 106 (1794).

*Aspongopus obscurus*, *Atk. J. A. S. B.* lviii. p. 88 (1889).

A common East-Indian species.

\*†*ASPONGOPUS NIGRIVENTRIS*.

*Aspongopus nigriventris*, *Hope, Cat. Hem.* p. 26 (1837).

A common East-Indian species.

\*†*PLACOSTERNUM TAURUS*.

*Cimex taurus*, *Fabr. Spec. Ins.* ii. p. 344, n. 34 (1781).

*Placosternum taurus*, *Atk. J. A. S. B.* lvii. p. 159 (1888).

Var. (?) *Placosternum alces*, *Stål, Vet.-Akad. Handl.* (2) xiv. (4) p. 107 (1876); *Atk. Journ. As. Soc. Beng.* lviii. p. 160 (1888).

Var. (?) *Placosternum urus*, *Stål, l. c.* (1876).

A common East-Indian insect. Until a long series of specimens are compared from various localities, it seems to me hazardous to attempt to separate the various forms into species, especially as some of the specimens in the series in the British Museum exhibit the characters which Stål assigns to the true *P. taurus* in much higher degree than the actual type of Fabricius.

Mr. Green has met with the smallest form on trunks of trees; it is a hill-country form (Pundaloya) and has an odour of Jargonelle pears. The largest form is a low-country insect (Colombo), and a middle-sized form occurs at Nawalapitya, at an intermediate elevation.

Mr. Green regards them as distinct species, but he has only met with the small form himself; and I do not think that we have sufficient information to decide the question positively, at present.

\*(?) *PHYLLOCEPHALA ÆGYPTIACA*.

*Pentatoma ægyptiaca*, *Lef. Mag. Zool.* i. pl. 20 (1831).

The only authority for the occurrence of this species in Ceylon is a specimen in the British Museum from Mr. Paul's collection, which, in all probability, is really from Egypt.

## COREIDÆ.

## DALADER ACUTICOSTA.

*Dalader acuticosta*, *Amyot & Serv. Hist. Nat. Hém.* p. 188, pl. iv. f. 7 (1843).

A common East-Indian species, recorded as Cinghalese by Dohrn.

## \*†DALADER PLANIVENTRIS.

*Acanonicus planiventris*, *Hope, Cat.* ii. p. 8 (1842).

Occurs in North India, Siam, and Ceylon. Mr. Green's specimen was without special locality.

Hardly distinct from the last species.

## \*†MICTIS PHASIANA.

*Cimex phasianus*, *Fabr. Spec. Ins.* ii. p. 361, n. 136 (1781).

*Myctis punctum*, *Hope, Cat.* ii. p. 10 (1842).

A common East-Indian species, but originally described by Fabricius as S.-African. Mr. Green's specimens are from Kalawawa (North Central Province), Colombo, and Nawalapitya.

## \*MICTIS CASTANEA.

*Mictis castanea*, *Dall. List Hem. Ins. B. M.* ii. p. 389 (1852).

The type is from Ceylon.

## \*MICTIS LATA.

*Mictis lata*, *Dall. List Hem. Ins. B. M.* ii. p. 390 (1852).

Recorded from Hong Kong, Malacca, and Ceylon.

## \*MICTIS VALIDA.

*Mictis valida*, *Dall. List Hem. Ins. B. M.* ii. p. 398 (1852).

Described from Ceylon. Remarkable for the very strong spines on the legs.

## \*TREMATOCORIS LOBIPES.

*Myctis lobipes*, *Hope, Cat.* ii. p. 11 (1842).

Recorded from Ceylon by Walker.

## \*†TREMATOCORIS CALCAR.

*Mictis calcar*, *Dall. List Hem. Ins. B. M.* ii. p. 397 (1852).

Occurs in India and Ceylon.

## \*BRACHYTES BICOLOR.

*Brachytes bicolor*, *Westw. Hope, Cat.* ii. p. 8 (1842).

A common Indian insect. There is a specimen in the British Museum from Ceylon, presented by Dr. Templeton.

*PHYSOMERUS GROSSIPES.*

*Lygæus grossipes*, *Fabr. Mant. Ins.* ii. p. 135, n. 4 (1787).

A well-known East-Indian species; recorded as Cinghalese by Dohrn.

\*†*HOMŒOCERUS MARGINIVENTRIS.*

*Homœocerus marginiventris*, *Dohrn, Stett. ent. Zeit.* xxi. p. 402, no. 40 (1860).

Described from Ceylon.

Two specimens in Mr. Green's collection from Pundaloya. The male differs in having the antennæ almost entirely yellow, only slightly browned towards the extremities of the joints, the lateral angles of the thorax much more sharply produced, and the abdomen much less speckled with black beneath, and with the lateral margins unspotted. It may be a distinct species; but I do not like to describe it as new, in the absence of a series.

\*†*HOMŒOCERUS ANTENNATUS*, sp. n. (Plate IV. fig. 6.)

Long. corp. 13 millim.

Head and front of pronotum rufo-testaceous, hinder part of pronotum, scutellum, and corium with the ground-colour paler, but so thickly speckled and reticulated with black as to look darker. Antennæ with joints 1 and 4 of equal length, the 2nd only slightly shorter, and the 3rd about half as long as the first. Antennæ reddish brown at the base, shading into black about the middle of the second joint; extreme base of the second joint, a ring at the base of the third, and a much broader one just beyond the base of the fourth, pale yellow. Lateral angles of the pronotum hardly prominent; lateral margins with a black line; the front of the prothorax with two black dots on each side of the pale median line, conspicuous under a strong lens. Towards the hinder part of the pronotum the punctures are much larger and darker, and are arranged in irregular undulating transverse lines. Scutellum and corium thickly punctured with black, the punctures along the nervures arranged in lines; edges of the scutellum and corium narrowly testaceous, and the tip of the scutellum bone-colour. Membrane fuscous, black at the base. Under surface rufo-testaceous; pectus with the punctures uni-

colourous; ventral surface of abdomen hardly punctured, the stigmata marked with black dots.

Allied to *H. marginiventris*, but the shoulder-angles less prominent.

In Mr. Green's collection, without special locality.

#### HOMŒOCERUS LÆVILINEUS.

*Homœocerus lævilineus*, Stål, *Svensk. Akad. Handl.* (2) xi. (2) p. 60 (1873).

Described from Ceylon.

I should have referred the male noticed under *H. marginiventris* to this species, but that the description appears to imply that the lateral angles of the thorax are less instead of more prominent in *H. lævilineus*.

#### HOMŒOCERUS CINGALENSIS.

*Tliponius cingalensis*, Stål, *Æfvers. Vet.-Akad. Förh.* xvi. p. 465 (1859).

*Homœocerus singhalensis*, Stål, *Vet. Akad. Handl.* (2) xi. (2) p. 60 (1873).

Recorded from China (Amoy) and Ceylon.

#### \*†HOMŒOCERUS SIGNATUS.

*Homœocerus signatus*, Walk. *Cat. Hem. Het. B. M.* iv. p. 97, n. 19 (1851).

*Homœocerus biplagiatus*, Stål, *Vet. Akad. Handl.* (2) xi. (2) p. 59, n. 14 (1873).

Described by Walker from Ceylon, and by Stål from Bombay. Mr. Green's specimen is from Kandy.

#### \*†HOMŒOCERUS WALKERI, sp. n.

*Homœocerus fascifer*, var. (?), Walk. *Cat. Hem. Het. B. M.* iv. p. 94, n. 13.

Long. corp. 19 millim.

Head, thorax, scutellum, under surface, the extreme base of the tegmina, and a narrow line disappearing beyond the middle of the costa dirty yellow; basal joint of antennæ brownish, second yellow, with the tip black, the rest wanting. Thorax granulated; a blackish line on each side of the head and along the lateral ridges of the thorax above; hinder part of thorax and tegmina dark brown; abdomen above reddish, the lateral margins yellow, rather broadly edged within with black. A cream-coloured spot in the

middle of the tegmina, and a linear one within it (sometimes continuous with it, and extending to the inner margin).

Much resembles *H. signatus*, Walk.; but the lateral angles of the thorax are less produced.

Occurs in India, Penang, and Ceylon.

I cannot make Stål's description of his *Tliponius fascifer* from Manilla agree with this insect.

\*†*HOMEOCERUS PROMINULUS*.

*Ceratopachys prominulus*, *Dall. List Hem. Ins. B. M.* ii. p. 501, n. 3 (1852).

Described from India. Mr. Green's collection contained a single specimen without special locality, labelled "*H. biplagiatus*."

\*†(?) *VERLUSIA RHOMBEA*.

*Cimex rhombeus*, *Linn. Syst. Nat.* i. (2) p. 718, n. 22 (1767).

A single immature specimen in Mr. Green's collection, without special locality, apparently belonging to this common European species.

\**ACANTHOCORIS SCABRATOR*.

*Coreus scabrator*, *Fabr. Syst. Rhyn.* p. 195, n. 19 (1803).

Common in the East Indies; but only included in the present list on the authority of a specimen received from Capt. Parry with the locality Ceylon.

\*†*ACANTHOCORIS ANTICUS*.

*Acanthocoris anticus*, *Walk. Cat. Hem. Het. B. M.* iv. p. 118, n. 15 (1871).

Common in Ceylon, and perhaps peculiar to that island.

\*†*ANISOMELIS ORIENTALIS*.

*Anisomelis orientalis*, *Dall. List Hem. Ins. B. M.* ii. p. 454, n. 8 (1852).

A common species in Siam, and throughout the Eastern Archipelago. The locality of Mr. Green's specimens was not indicated.

\*†*PLINACHTUS ACICULARIS*.

*Alydus acicularis*, *Fabr. Syst. Rhyn.* p. 251, n. 14 (1803).

*Leptoscelis ventralis*, *Dall. List. Hem. Ins. B. M.* ii. p. 458, n. 10 (1852).

Described by Fabricius from Tranquebar, and said to be a very variable insect. Mr. Green's specimen, which is simply labelled



"Ceylon," is much more varied with red than the type of Dallas's species, which is also from Ceylon. A full series is much wanted.

**PLINACTUS PELTASTES.**

*Plinactus peltastes*, *Stål, Stett. ent. Zeit.* xxii. p. 144 (1861).

Described from Ceylon.

**SERINETHA DALLASI.**

*Serinetha Dallasi*, *Dohrn, Stett. ent. Zeit.* xxi. p. 402, n. 42 (1860).

Described from Ceylon.

**\*†SERINETHA AUGUR.**

*Cimex augur*, *Fabr. Spec. Ins.* ii. p. 366, n. 167 (1781).

Common in India and Ceylon.

**\*†SERINETHA ABDOMINALIS.**

*Lygæus abdominalis*, *Fabr. Syst. Rhyng.* p. 227, n. 111 (1803).

Common in India and the Eastern Archipelago.

**\*†SERINETHA TAPROBANENSIS.**

*Serinetha taprobanensis*, *Dall. List Hem. Ins. B. M.* ii. p. 461, n. 6 (1852).

Hardly distinct from *S. abdominalis*.

One of the commonest species in Ceylon (*E. E. G.*).

**\*†SERINETHA COXALIS, sp. n.**

Long. corp. 14 millim.

Red; antennæ, except at extreme base beneath, scutellum, membrane, legs except the coxæ, pectus, and ventral surface of abdomen except at the sides and extremity, black.

Exact locality not specified.

Easily recognizable by the conspicuous red coxæ on a black background.

**\*LYBAS TURPIS.**

*Lybas turpis*, *Walk. Cat. Hem. Het. B. M.* iv. p. 150, n. 5 (1871).

Described from Ceylon. (Collected by Dr. Templeton.)

Very like a species of *Homæocerus* in appearance.

**\*†CAMPTOPUS LINEARIS.**

*Cimex linearis*, *Fabr. Syst. Ent.* p. 710, n. 62 (1775).

*Alydus clavatus*, *Dohrn, Stett. ent. Zeit.* xxi. p. 402, n. 43 (1860).

A common East-Indian species.

The extent of black on the pectus and ventral surface of the abdomen varies; but the middle line of the pectus at least is always black, though the abdomen itself varies from rufo-testaceous to black; but even in the latter case the sides are always pale.

Mr. Green's specimens are from Pundaloya and Nitagala.

\*†CAMPTOPUS VENTRALIS.

*Alydus ventralis*, *Hope, Cat. Hem.* ii. p. 20 (1842).

*Alydus major*, *Dohrn, Stett. ent. Zeit.* xxi. p. 402 (1860).

Occurs in India, Ceylon, China, and Japan.

In some specimens the pleural spots are obsolete, and in others (representing *Alydus major*) there is a broad cream-coloured stripe on the lower part of the head, running below the eyes, and a long constricted spot (sometimes divided into two) on the meso- and metapleuræ, besides some smaller intermediate dots of the same colour.

\* (?) LEPTOCORISA ANGUSTATA.

*Cimex angustatus*, *Fabr. Mant. Ins.* ii. p. 308, n. 300 (1787).

Occurs in the East Indies and Australia.

A single damaged specimen from Ceylon stands under this name in the Museum collection, obtained from Dr. Templeton; but it hardly appears to differ from the following species.

\*†LEPTOCORISA VARICORNIS.

*Gerris varicornis*, *Fabr. Syst. Rhyng.* p. 260, n. 2 (1803).

Common throughout the tropics of the Old World.

Always found in grass-fields (*E. E. G.*).

Mr. Green's specimens are from Pundaloya and Nawalapitya.

\*†CLETUS FEMORALIS, sp. n.

Long. corp.  $10\frac{1}{2}$  millim.

Head and thorax above granulated, with a pale median line; antennæ castaneous, joints 1 and 2 beneath and the base of joint 4 blackish; head blackish above, which colour extends to the base of the thorax, the sloping portion of which is testaceous, granulated with black; and there is a transverse row of black spots just above the dusky portion at the base; hinder part of the thorax darker brown, the projecting angles acute, nearly straight in front, the ridges of the thorax behind sinuated and denticulated; scutellum and corium nearly concolorous with the thorax, but the latter shading into reddish, and edged with a red line; a

white dot at the end of the scutellum, and another, more distinct, within the inner edge of the red line bounding the corium; membrane fusco-hyaline. Abdomen black, edged with yellow. Under-side yellowish, the thorax strongly granulated with brown; a row of black dots along the sides of the thorax and abdomen and others on the median line of the throat; the spotting of the abdomen is somewhat irregular, but there is first a semicircle of rather large dots, within which are irregular smaller ones, and on each of the two following segments there is a transverse row of small dots at the base and another of larger ones at the extremity. Hind femora very distinctly spotted beneath, the other legs less so.

Allied to *C. calumniator*, Fabr., and *C. punctulatus*, Dall., but easily recognized by the peculiar arrangement of the spots, and by the spotted hind femora. A single specimen taken by Mr. Green at Mungphe.

\*†CLETUS BIPUNCTATUS.

*Coreus bipunctatus*, Hope, *Cat.* ii. p. 23 (1842).

Described from India. Mr. Green's specimen is labelled "Putlam." Dohrn's two species which follow are closely allied to this.

\*†CLETUS BISTILLATUS.

*Cletus bistillatus*, Dohrn, *Stett. ent. Zeit.* xxi. p. 403 (1860).

Described from Ceylon. Mr. Green's specimen is without special locality.

I am not quite certain whether the specimen which I have referred to this species really belongs to it, as there is little or no red at the extremity of the corium.

\*†CLETUS ELONGATUS.

*Cletus elongatus*, Dohrn, *Stett. ent. Zeit.* xxi. p. 403, n. 47 (1860).

Described from Ceylon.

\*†CLETOMORPHA (?) DENTICULATA, sp. n.

*Cletomorpha denticulata*, Atkinson, *MS.*

Long. corp. 7-8 millim.

Brown, granulated; front of the thorax sloping and, as well as the head, paler—in the smaller specimen intersected by a whitish median line, and with the lateral borders and hind border of the pale portion of the thorax whitish; hinder part of the thorax, scutellum, and corium darker brown, the latter with a narrow white fascia, hardly divided into spots, running from two

thirds of the length of the costa to the inner margin. Antennæ and legs testaceous; the first joint of the antennæ much thickened but hardly as long as the second; the third distinctly shorter, the fourth much shorter, forming an oval club. Spines of the thorax strong, concolorous; lateral margins before the spine with two small teeth near together in front, and three large isolated ones behind; lateral margins behind the spine with three or four small teeth; hinder edge of thorax concave. Membrane hyaline (possibly darker towards the base). Abdomen blackish, with large, dull yellow marginal spots; abdominal angles produced. Underside brown in the larger specimen and pale in the smaller one, indistinctly speckled with darker.

Described from two specimens (labelled "Putlam"), one much larger and darker than the other, in Mr. Green's collection. There is a third, without locality, among the series of specimens in the British Museum, referred (erroneously I think) to *C. lanciger*, Fabr., by Walker.

\**CLETOMORPHA WALKERI*, sp. n.

Long. corp. 5 millim.

Much resembles the last species, but rather shorter and broader.

Head and thorax dark brown, granulated; the sloping part of the thorax with the back and sides, and a median line extending to the head, testaceous; thoracic spines very acute; the lateral margins of the thorax in front entirely unarmed, behind with two or three minute teeth, the last forming a distinct angle; hinder edge of thorax slightly concave. Scutellum with the extreme base testaceous, expanding into spots at the sides; the tip may also possibly be testaceous. Inner angle of the corium with one or two small white spots, representing the inner part of the fascia in the last species. Antennæ, membrane, abdomen, legs, under surface, &c. as in the last species; but with a rather more distinct row of black dots on the sides of the abdomen.

The type of this species is a specimen from Ceylon, referred to *C. lanciger*, Fabr., in Walker's Catalogue.

Three other specimens placed under *C. lanciger* by Walker, one of which is from Pulo Penang, resemble this species in shape; but the sloping part of the thorax and the head are testaceous above (not blackish in the middle), there are no pale markings on

the scutellum, and the fascia on the corium consists of three very distinct small white spots. It may be called *Cletomorpha benita*.

\*†CLAVIGRALLA HORRENS.

*Clavigralla horrens*, *Dohrn, Stett. ent. Zeit.* xxi. p. 403, n. 48 (1860).

Described from Ceylon. Mr. Green's specimens are from Pundaloya and Nitagala.

In some of the specimens of what I take to be this species, a series of white markings runs along the whole side of the body from below the eye to the extremity of the abdomen, which is spotted and blotched with white.

CLAVIGRALLA CONCOLOR.

*Clavigralla concolor*, *Dohrn, Stett. ent. Zeit.* xxi. p. 403, n. 49 (1860).

Described from Ceylon.

\*†RHOPALUS RUBICUNDUS.

*Corizus rubicundus*, *Sign. Ann. Soc. Ent. France*, (3) vii. p. 86, n. 15 (1859).

Described from Ceylon. One of Mr. Green's specimens is labelled "Haragam."

I believe I have correctly identified this species; but all the specimens before me are red and black, and not one can be correctly called "jaune doré plus ou moins orange," as Signoret describes his species. Dohrn's MS. name, adopted by Signoret, applies much better to the insect than Signoret's description, which may have been taken from discoloured specimens.

\*†RHOPALUS (?) FUNERALIS, sp. n. (Plate IV. fig. 7.)

Long. corp. cum tegm. 3 millim.

Head, pronotum, and scutellum black, with large round punctures and short scattered bristles; tegmina brown, the part immediately bordering on the scutellum black and deeply pitted; corium with a large, triangular, ivory-white spot just beyond the base, which is marked with much smaller punctures; costa ivory-white, membrane brown with paler borders; legs and antennæ black or reddish brown, tibiæ white above, front femora slightly thickened.

Nitagala.

A small narrow species, only referred to the genus *Rhopalus* provisionally.

## LYGÆIDÆ.

## \*†LYGÆUS MILITARIS.

*Cimex militaris*, *Fabr. Syst. Ent.* p. 717, n. 103 (1775).

A very widely-distributed species in the Old World.

Mr. Green's specimen was without special locality.

## \*†LYGÆUS HOSPES.

*Lygæus hospes*, *Fabr. Syst. Ent.* iv. p. 150, n. 50 (1794).

Recorded from India and China.

## \*†LYGÆUS ARGENTATUS.

*Lygæus argentatus*, *Fabr. Syst. Rhyn.* p. 228, n. 120 (1803).

Recorded from India, Burma, and Ceylon.

## \*LYGÆUS LEUCURUS.

*Lygæus leucurus*, *Fabr. Mant. Ins.* ii. p. 299, n. 202 (1787).

Recorded from the Island of Amsterdam, Philippines, Lombok, and Ceylon (from Dr. Thwaites' collection).

## \*†LYGÆUS SERVUS.

*Cimex servus*, *Fabr. Mant. Ins.* ii. p. 300, n. 207 (1787).

Common in the tropics of the Old World.

## LYGÆUS MACULATUS.

*Lygæus maculatus*, *Dall. List Hem. Ins. B. M.* ii. p. 545 (1852).

Described from India. Dohrn includes it in his list as *Cinghalese*.

## \*†LYGÆUS QUADRATOMACULATUS, sp. n. (Plate IV. fig. 13.)

Long. corp. cum tegm. 10 millim.

Head and thorax above red; head with the tip black and two large black spots on the vertex between the eyes; pronotum with a black transverse stripe on each side; mesonotum with the greater part of each side filled up by a large square black spot; scutellum black, with a red longitudinal line; corium dark greyish brown, with a round, deep black spot in the middle; membrane blue-black, with the tips bordered first with testaceous and beyond with clear hyaline; antennæ and legs black, the latter covered with grey pile; head and pectus red, the pleura with two rows of 3 black spots on each side; proboscis black; abdomen clothed beneath with dark grey pile.

Pundaloya.

A handsome species, allied to *L. argentatus*; but the latter has no black spot on the tegmina, and only one row of black spots on the pleura on each side, besides other differences in marking, &c.

**NYSIUS SUBCINCTUS.**

*Nysius subcinctus*, *Walk. Cat. Hem. Het. B. M. v. p. 70, n. 31* (1872).

Described from Ceylon.

**NYSIUS PALLIPENNIS.**

*Nysius pallipennis*, *Walk. Cat. Hem. Het. B. M. v. p. 71, n. 32* (1872).

Described from Ceylon.

**NYSIUS CEYLANICUS.**

*Heterogaster ceylanicus*, *Motsch. Bull. Mosc. xxxvi. (3) p. 73* (1863).

Described from Ceylon (Nura Ellia, Patannas, and Colombo).

**\*HETEROGASTER SIGNIFER.**

*Heterogaster signifer*, *Walk. Cat. Hem. Het. B. M. v. p. 74, n. 12* (1872).

Described from Ceylon.

**HETEROGASTER SEMICRUCIATUS.**

*Coryzus semicruciatu*s, *Motsch. Bull. Mosc. xxxvi. (3) p. 77* (1863).

Described from Ceylon (Nura Ellia).

The description seems to agree with *H. signifer*, Walk.

**HETEROGASTER (?) BREVICOLLIS.**

*Coryzus brevicollis*, *Motsch. Bull. Mosc. xxxvi. (3) p. 77* (1867).

Described from Ceylon (Nura Ellia).

**RHYPAROCHROMUS (?) CRASSICEPS.**

*Rhyparochromus* (?) *crassiceps*, *Dohrn, Stett. ent. Zeit. xxi. p. 404, n. 57* (1860).

Described from Ceylon.

**\*†RHYPAROCHROMUS TESTACEIPES.**

*Rhyparochromus testaceipes*, *Walk. Cat. Hem. Het. B. M. v. p. 101, n. 160* (1872).

Perhaps identical with *R. (?) crassiceps*, Dohrn.

## \*†RHYPAROCHROMUS LEUCOCERAS.

Rhyparochromus leucoceras, *Walk. Cat. Hem. Het. B. M.* v. p. 102, n. 158 (1872).

Apparently the commonest species of the genus in Ceylon. Resembles the descriptions of *Dieuches punctipes* and *femoralis*, Dohrn, in several particulars.

Found under stones and rubbish, such as decaying leaves (*E. G.*).

## RHYPAROCHROMUS BREVIS.

Rhyparochromus brevis, *Motsch. Bull. Mosc.* xxxvi. (3) p. 78 (1863).

Described from Ceylon (Patannas).

## RHYPAROCHROMUS FUSCONERVOSUS.

Rhyparochromus fusconervosus, *Motsch. Bull. Mosc.* xxxvi. (3) p. 79 (1863).

Described from Ceylon (Colombo).

## RHYPAROCHROMUS SINGALENSIS.

Rhyparochromus singalensis, *Dohrn, Stett. ent. Zeit.* xxi. p. 404 (1860).

Described from Ceylon.

## \*†RHYPAROCHROMUS GREENI, sp. n.

Long. corp. 8 lin.

Dark brown; head, antennæ, front of pronotum, scutellum, under surface, and femora black; hinder part of pronotum and corium dark reddish brown; front and lateral margins of pronotum and costa of corium testaceous; antennæ with the third joint shortest, and white at its extremity; hind part of pronotum and pectus strongly punctured, abdomen beneath much more finely; membrane brown, with small whitish mottlings; tibiæ and tarsi reddish brown.

Closely allied to *R. sordidus*, Fabr., but darker.

Pundaloya.

## DIEUCHES PUNCTIPES.

Dieuches punctipes, *Dohrn, Stett. ent. Zeit.* xxi. p. 405, n. 61 (1860).

Described from Ceylon.

## DIEUCHES FEMORALIS.

Dieuches femoralis, *Dohrn, Stett. ent. Zeit.* xxi. p. 405, n. 62 (1860).

Described from Ceylon.



## \*†PLOCIMERUS DISCOGUTTATUS.

*Plociomerus discoguttatus*, *Dohrn, Stett. ent. Zeit.* xxi. p. 404, n. 58 (1860).

Described from Ceylon.

## \*†PLOCIMERUS BENGALENSIS.

*Rhyparochromus bengalensis*, *Dall. List Hem. Ins. B. M.* ii. p. 572, n. 34 (1852).

A rather large species, with the lateral margins of the thorax concolorous. Recorded from Hong Kong, Cambodia, India, and Ceylon, but apparently not very common anywhere.

Mr. Green's specimen is without locality.

## PLOCIMERUS UNDULATUS.

*Plociomerus undulatus*, *Dohrn, Stett. ent. Zeit.* xxi. p. 404, n. 59 (1860).

Described from Ceylon.

## PLOCIMERUS NIETNERI.

*Plociomerus Nietneri*, *Dohrn, Stett. ent. Zeit.* xxi. p. 404, n. 60 (1860).

Described from Ceylon.

## \*†PLOCIMERUS INCISUS.

*Rhyparochromus incisus*, *Walk. Cat. Hem. Het. B. M.* v. p. 100, n. 158 (1872).

Described from Ceylon. Mr. Green's specimen is from Nitagala.

Possibly the same as *P. Nietneri*, Dohrn; but a good series of the closely allied species of *Rhyparochromus* and *Plociomerus* would be needed to clear up the synonymy of the Cinghalese species, which appear to be rather numerous.

## PLOCIMERUS PUNCTULATUS.

*Plociomerus punctulatus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 79 (1863).

Described from Ceylon (Colombo), but said to be also found in Egypt.

## PLOCIMERUS FLAVIPES.

*Plociomerus flavipes*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 80 (1863).

Described from Ceylon (Colombo).

*PLOCIOMERUS GENICULATUS.*

*Plociomerus geniculatus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 81 (1863).

Described from Ceylon (Colombo).

*PLOCIOMERUS BISPINUS.*

*Plociomerus bispinus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 81 (1863).

Described from Ceylon (Nura Ellia).

I have not been able to recognize any of Motschulsky's Cinghalese species of *Plociomerus* among the specimens before me.

\*†*MACROPUS SPINIMANUS.*

*Macropus spinimanus*, *Motsch. Études Ent.* viii. p. 108 (1859); *Bull. Mosc.* xxxvi. (3) p. 82, t. 2. f. 19 (1863).

Described from Ceylon. Mr. Green's specimen is from Nitagala.

*MACROPUS DENTIPES.*

*Macropus dentipes*, *Motsch. Études Ent.* viii. p. 108 (1859).

Described from Ceylon.

\*†*OXYCARENUS LÆTUS*, sp. n.

Long. corp. 4 lin.

*Female.* Black, hairy, deeply punctured; sides of abdomen both above and below bright red nearly to the tip and marked with red between; corium hyaline, with yellowish nervures and a dusky spot at the tip; membrane and wings hyaline; sides of pectus spotted with dull red; tibiæ and first joint of tarsi yellow; four hinder tibiæ banded with black at base and tip; front femora spiny beneath.

Closely allied to the common S. European and African *O. tardus*, Hahn (= *O. lavateræ*, auct.; ? Fabr.).

The type is from Hambantotta.

*OXYCARENUS* (?) *LUGUBRIS.*

*Stenogaster* (?) *lugubris*, *Motsch. Études Ent.* viii. p. 108 (1859).

Described from Ceylon, and said to be common.

\**ISCHNODEMUS CENTRALIS.*

*Ischnodemus centralis*, *Walk. Cat. Hem. Het. B. M.* v. p. 132, n. 31 (1872).

Described from Ceylon.

## \*OPHTHALMICUS CINCTICORNIS.

Ophthalmicus cincticornis, *Walk. Cat. Hem. Het. B. M. v. p. 138, n. 32* (1872).

Described from Ceylon.

## \*OPHTHALMICUS DISPAR.

Ophthalmicus dispar, *Walk. Cat. Hem. Het. B. M. v. p. 139, n. 33* (1872).

Described from Ceylon.

## \*OPHTHALMICUS DISCIFER.

Ophthalmicus discifer, *Walk. Cat. Hem. Het. B. M. v. p. 139, n. 34* (1872).

Described from Ceylon.

## CYMUS BASICORNIS.

Cymus basicornis, *Motsch. Bull. Mosc. xxxvi. (3) p. 90* (1863).

Described from Ceylon (Colombo).

## GEOCORIS MARGINICOLLIS.

Geocoris marginicollis, *Dohrn, Stett. ent. Zeit. xxi. p. 405, n. 63* (1860).

Described from Ceylon.

## ANTHOCORIS FUNEBRIS.

Anthocoris funebris, *Motsch. Bull. Mosc. xxxvi. (3) p. 88* (1863).

Described from Ceylon (Nura Ellia).

## ANTHOCORIS PARALLELUS.

Anthocoris parallelus, *Motsch. Bull. Mosc. xxxvi. (3) p. 89* (1863).

Described from Ceylon (Nura Ellia and Colombo).

## ANTHOCORIS TANTILLUS.

Anthocoris tantillus, *Motsch. Bull. Mosc. xxxvi. (3) p. 89* (1863).

Described from Ceylon (Colombo).

## \*XYLOCORIS FUMIPENNIS.

Xylocoris fumipennis, *Walk. Cat. Hem. Het. B. M. v. p. 160, n. 15* (1872).

Described from Ceylon.

## PYRRHOCORIDÆ.

## \*+ODONTOPUS COQUEBERTI.

Lygæus Coqueberti, *Fabr. Syst. Rhyng. p. 222, n. 86* (1803).

Common in the East Indies; varies a little in size.

Mr. Green's specimens are from Colombo.

## \*†ODONTOPUS VARICORNIS.

*Cimex varicornis*, *Fabr. Mant. Ins.* ii. p. 298, n. 194 (1787).

Recorded from India, Ceylon, and Java.

Mr. Green's specimen is from Kandy.

## \*†ODONTOPUS LINEATIPES.

*Odontopus lineatipes*, *Stål, Œfv. Vet.-Akad. Handl.* xv. p. 441 (1858).

*Dysdercus lineatipes*, *Dohrn, Stett. ent. Zeit.* xxi. p. 405, n. 65 (1860).

A very handsome species. Mr. Green's specimen is without locality.

## \*†DYSDERCUS CINGULATUS.

*Cimex cingulatus*, *Fabr. Syst. Ent.* p. 719, n. 108 (1775).

Abundant from India to Australia. The typical form, with black legs and a black band on the front of the thorax, seems to be scarcer in Ceylon than the redder varieties.

Mr. Green's specimens are from Pundaloya and Hambantotta.

## \*†DINDYMUS SITA, sp. n. (Plate IV. fig. 18.)

Long. corp. 13 millim.

Rufo-testaceous, inclining to sanguineous towards the lateral margin of the thorax, and at the edges of the corium, especially beneath; clothed with fine yellowish-grey pubescence, most thickly on the pectus; antennæ black, the basal half of the last segment white. Thorax with the front and sides of nearly equal length, but widened behind, so that the hind border is about half as long again as the others; the lateral margins are slightly raised, and a groove runs across the middle, behind which the thorax is closely and thickly punctured, as are also the edges of the corium bordering on the scutellum. Membrane fusco-hyaline, with a large oval black spot at the base. The rostrum extends to the middle coxæ. Femora rufo-testaceous; knees, tibiæ, and tarsi blackish; front femora thickened and denticulated, several of the intermediate teeth being larger than the others.

Pundaloya.

Much resembles a species from Hong Kong, Philippines, Dorey, &c., ticketed *Dysdercus monostigma* by Walker; but all the specimens of the latter species are much longer and narrower, with the antennæ black, or with the penultimate segment, and some-

times also the basal ones, inclining to red; and there is generally a black line at the base of the scutellum.

*MELAMPHAUS FULVOMARGINATUS.*

*Dysdercus fulvomarginatus*, *Dohrn, Stett. ent. Zeit.* xxi. p. 405, n. 66 (1860).

Described from Ceylon.

\*†*MELAMPHAUS LATERALIS.*

*Melamphaus lateralis*, *Walk. Cat. Het. Hem. B. M.* vi. p. 13, n. 4 (1873).

Described from Ceylon. Mr. Green's specimens are from Deltota.

I suspect that a large series would show that *Dysdercus fulvomarginatus*, *Dohrn*, and *Melamphaus marginalis*, *Walk.*, are nothing more than discoloured specimens of this insect, which will then represent the normal form of the species, for which, however, *Dohrn's* name must then be retained; indeed, one of Mr. Green's specimens was actually labelled *D. fulvomarginatus* by the late Mr. Atkinson.

\*†*MELAMPHAUS MARGINALIS.*

*Melamphaus marginalis*, *Walk. Cat. Het. Hem. B. M.* vi. p. 14, n. 6 (1873).

Described from Ceylon. Mr. Green's specimen is from Nawalapitya.

\**MELAMPHAUS RUBIDUS.*

*Melamphaus rubidus*, *Walk. Cat. Het. Hem. B. M.* vi. p. 14, n. 7 (1873).

Described from Ceylon.

Singularly resembles a Reduviid in Mr. Green's collection.

\*†*PHYSOPELTA GUTTA.*

*Lygæus* (*Pyrrhocoris*) *gutta*, *Burm. Nova Acta Acad. Leop.-Carol.* xvi. *Suppl.* p. 300, pl. xli. f. 10 (1834).

A common East-Indian species.

Mr. Green's specimen is without special locality.

CAPSIDÆ.

*CAPSUS SEMICLUSUS.*

*Capsus semiclusus*, *Walk. Cat. Het. Hem. B. M.* vi. p. 118, n. 275 (1873).

Described from Ceylon.

*CAPSUS SUBIRRORATUS.*

*Capsus subirroratus*, *Walk. Cat. Het. Hem. B. M.* vi. p. 119, n. 277 (1873).

*CAPSUS INCISURATUS.*

*Capsus incisuratus*, *Walk. Cat. Hem. Het. B. M.* vi. p. 121, n. 282 (1873).

Described from Ceylon.

*CAPSUS ALBIPES.*

*Capsus albipes*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 82 (1863).

Described from Ceylon (Patannas).

*\*†CAPSUS RAVANA*, sp. n. (Plate IV. fig. 10.)

Long. corp. 7 millim.

Testaceous, more or less mottled and speckled with reddish; head and pronotum with longitudinal reddish or brownish stripes; pronotum longitudinally striated, with the shoulder-angles rather prominent; scutellum punctured, brownish, with three pale longitudinal lines meeting at the tip; tegmina and wings hyaline; carina with the nervures yellowish towards the base and red towards the extremity, enclosing a large yellow space, of a long triangular form, on the costa at the extremity of the corium. Antennæ reddish, thickened towards the extremity of the second joint, and the terminal joints darker, as are likewise the tarsi.

Pundaloya, very common.

Somewhat approaches the genus *Lopus*.

*\*†CAPSUS RAMA*, sp. n.

Long. corp. 8-10 millim.

Yellow, vertex with a slender black line between the eyes, and meeting behind them; pronotum blackish at the base, and with narrow black central and marginal lines, or with three short black lines at the base, the central line reddish, and the lateral lines reddish, black only at the base; pale part of the pronotum transversely striated, the hinder margin black, the lateral angles not produced. Scutellum transversely striated, more or less black towards the base and extremity, and divided by a deep groove. Wings hyaline, the corium with brown nervures; the costal nervure, and the opaque space at the extremity of the corium reddish, the latter yellowish in the centre. Antennæ reddish brown, darker or lighter, the second joint not distinctly thickened, joints 3 and 4 narrowly yellow at base. Legs yellowish, tarsi black, hind

femora dotted with brown, hind tibiæ red. Under surface of body yellow, with a narrow red line on each side.

Pundaloya.

Allied to *Capsus lineifer*, Walk.

\*†CAPSUS ANTENNATUS, sp. n.

Long. corp. 7–8 millim.

Head and pronotum testaceous, finely punctured, pronotum frequently varied with brown in the middle or behind; antennæ with the last three joints more or less black at the extremities, and the second often black in the middle as well; scape sometimes likewise black; scutellum brown, tip usually testaceous; corium brown, set with short white bristles; costa broadly testaceous, intersected by a large reddish-brown spot just before the extremity; legs testaceous, more or less dotted with brown, and with two obsolete brown bands towards the tip of the hind femora; legs with longer bristles than the other Cinghalese *Capsi*. Pectus blackish in the middle; ventral surface of the abdomen variable in colour, reddish, testaceous, or blackish.

Pundaloya.

\*†CAPSUS LANKANUS, sp. n.

Long. corp. cum tegm. 4 millim.

Head and thorax black, antennæ with the base of the first and third joints white; eyes white, clavus black; corium chestnut-brown, with a white transverse band near the base, and another preceding the tip, which is blackish; membrane and wings subhyaline; abdomen beneath with a broad white transverse band at the base.

The type is from Nitagala.

DERÆOCORIS RUBROVULNERATUS.

*Deræocoris rubrovulneratus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 83 (1863).

Described from Ceylon (Nura Ellia).

DERÆOCORIS VIRIDANUS.

*Deræocoris viridanus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 83 (1863).

Described from Ceylon (Nura Ellia).

DERÆOCORIS PICEONIGER.

*Deræocoris piceoniger*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 84 (1863).

Described from Ceylon (Colombo).

## LEPTOMEROCORIS SIMPLEX.

Leptomerocoris simplex, *Walk. Cat. Hem. Het. B. M.* vi. p. 145, n. 107 (1873).

Described from Ceylon.

## LEPTOMEROCORIS ALBIVIRIDESCENS.

Leptomerocoris albiviridescens, *Motsch. Bull. Mosc.* xxxvi. (3) p. 85 (1866).

Described from Ceylon (Patannas).

## LEPTOMEROCORIS (?) PISTACINUS.

Leptomerocoris (?) pistacinus, *Motsch. Bull. Mosc.* xxxvi. (3) p. 85 (1863).

Described from Ceylon (Patannas).

## LEPTOMEROCORIS (?) ALBOFASCIATUS.

Leptomerocoris (?) albofasciatus, *Motsch. Bull. Mosc.* xxxvi. (3) p. 86 (1863).

Described from Ceylon (Patannas).

## \*†LEPTOMEROCORIS PUNCTATUS, sp. n.

Long. corp. 5 millim.

Testaceous ; pronotum more yellow ; a band of 3 large, nearly connected black spots runs from behind each eye to the lateral angles of the pronotum, and there are 4 more conspicuous black spots arranged in a semicircle in front of the pronotum. Scutellum and corium longitudinally striped with black and testaceous: towards the extremity of the corium is a red spot on the costa bordered with yellow, and with a black spot before and behind. Membrane with the nervure black and a short black streak beyond it.

Exact locality not stated.

## LIOCORIS GLABRATUS.

Liocoris glabratus, *Motsch. Bull. Mosc.* xxxvi. (3) p. 87, pl. ii. f. 20 (1863).

Described from Ceylon (Nura Ellia and Patannas).

## \*MONALOCORIS BIPUNCTIPENNIS.

Monalocoris bipunctipennis, *Walk. Cat. Hem. Het. B. M.* vi. p. 159, n. 2 (1873).

Described from Ceylon.



## \*†HELOPELTIS ANTONII.

*Helopeltis Antonii*, *Sign. Ann. Soc. Ent. France*, (3) vi. p. 502, pl. xii. f. 2 (1858).

Common on tea, cocoa, and cotton in Ceylon; particularly injurious to cocoa (*E. E. G.*).

Several closely allied species are met with in Java, New Guinea, &c.

## TINGIDIDÆ.

## \*DICTYONOTA CINGALENSIS.

*Dictyonota cingalensis*, *Walk. Cat. Hem. Het. B. M.* vi. p. 178, n. 14 (1873).

Appears to be a common species in Ceylon.

## MONANTHIA SUBOVATA.

*Monanthia subovata*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 91 (1863).

Described from Ceylon (Colombo).

This species is probably allied to *Dictyonota cingalensis*, Walker.

## \*†MONANTHIA (?) ATRA.

*Monanthia atra*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 91 (1863).

Described from Ceylon (Patannas).

Taken by Mr. Green at Nitagala.

## MONANTHIA (?) TINGOIDES.

*Monanthia (?) tingoides*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 92 (1863).

Described from Ceylon (Nura Ellia).

## \*†ELASMOGNATHUS GREENI, sp. n. (Plate IV. fig. 5.)

Long. corp. 6 millim.

Narrow, linear, deep black; antennæ (except the scape and terminal joints, which are black) and the legs (except the black tarsi) rufo-testaceous; the front of the thorax also shows a tendency to this colour. Head with three strong spines above; antennæ with the first two joints short and broad, third very long and slender, fourth half as long as the third and pubescent. Thorax with two large lateral lobes, projecting upwards and forwards, very coarsely rugose; on the median line runs a continuous carina, and there are also lateral ones, interrupted by the lobes; tegmina black, with long vitreous spots along the costa,

interrupted in the middle and at the tip, and a row of smaller ones in the middle of the hind margin.

A much larger and narrower species than the Indian *E. Helferi*, Fieb.

Pundaloya and Nitagala. Found on wild pepper (*E. E. G.*).

\*†*ELASMOGNATHUS PALLIDA*, sp. n.

Size and shape of *E. Greeni*, which it closely resembles except in colour. Pale testaceous; head black above; spines and antennæ pale, terminal joint of antennæ black, except at the base; thorax with the front and the lateral appendages nearly white; rest of thorax and tegmina slightly browner, except on the margins, which are rather broadly vitreous; legs testaceous; tarsi slightly darker.

Nitagala.

Perhaps only a variety of *E. Greeni*.

\*†*TINGIS GLOBULIFERA*. (Plate IV. fig. 11.)

*Tingis globulifera*, *Walk. Cat. Hem. Het. B. M.* vi. p. 182, n. 27 (1873).

Mr. Green's specimens are from Nitagala and vary a little in depth of colour.

The types are from Madras, where the insect is stated to live on heliotrope.

\*†*BRACHYRHYNCHUS ORIENTALIS*.

*Brachyrhynchus orientalis*, *Lap. Hém.* 54.

*Crimia nigra*, *Dohrn, Stett. ent. Zeit.* xxi. p. 406, n. 71 (1860).

An abundant species throughout the East Indies.

Mr. Green's specimens are from Colombo and Pundaloya.

\**CRIMIA VERRUCICOLLIS*.

*Crimia verrucicollis*, *Walk. Cat. Hem. Het. B. M.* vii. p. 13, n. 6 (1873).

Described from Ceylon.

\**CRIMIA LATERALIS*.

*Crimia lateralis*, *Walk. Cat. Hem. Het. B. M.* vii. p. 14, n. 7 (1873).

Described from Ceylon.

\**CRIMIA RUBRESCENS*.

*Crimia rubescens*, *Walk. Cat. Hem. Het.* vii. p. 14, n. 8 (1873).

Abundant from India to Australia.

Mr. Green's collection contained specimens of two species of *Crimia*, apparently distinct from any of the foregoing, but which I do not describe because they are immature.

### CIMICIDÆ.

#### \**CIMEX LECTULARIUS*.

*Cimex lectularius*, *Linn. Syst. Nat.* i. p. 441, n. 1 (1758).

A cosmopolitan species; but there is some reason to believe that it was originally confined to Africa, where it has always been known by the name of Bug, or at least to the tropical and sub-tropical regions of the Old World, and that it was introduced into America by slave-ships, and brought thence to Northern Europe. It was known to Aristotle as occurring in the Mediterranean Region in his time; but I believe the earliest recorded date of its having been observed in England is 1503.

Nevertheless Mr. C. O. Waterhouse informs me that an insect which cannot be distinguished from this is found in the Lower Tertiaries of Scotland; but even granting that the identification is correct, this insect, like the rest of the then existing fauna and flora, would almost certainly have been driven out or exterminated by the Glacial Period; and we cannot therefore admit that the observation proves more than that the insect may have been an inhabitant of Scotland at some former period.

### REDUVIIDÆ.

#### \*†*LESTOMERUS HORRIDUS*, sp. n. (Plate IV. fig. 16.)

Long. corp. 20 millim.

Blue-black, sparingly clothed with long bristles; extremities of tibiæ and tarsi showing a tendency to shade into rufo-testaceous; wings rudimentary; inner portion of tegmina testaceous; abdomen with testaceous marginal spots on the front of each segment both above and below; front femora thickened; vertex grooved; frontal lobe of thorax with a shallow groove at the back and with three shallow oblique depressions on each side; hinder lobe not grooved.

The type is not quite mature.

Allied to *L. affinis*, Serv.; but this is a shorter and broader insect, with the abdominal margins unspotted.

Except that the legs are black, it has likewise much resemblance

to *Pirates ruffemur*, Walk., which should perhaps be referred to the present genus.

Konigala, Jan. 1890 (*E. E. G.*).

\*PIRATES RUFFEMUR.

*Pirates ruffemur*, Walk. *Cat. Hem. Het. B. M.* vii. p. 119, n. 76 (1873).

Described from Ceylon.

\*†PIRATES CUMINGI.

Rascelius Cumingi, *Dohrn, Stett. ent. Zeit.* xxi. p. 407, n. 95 (1860).

Described from Ceylon.

Mr. Green's specimens are without special locality. They are labelled "*Sirthenes flavipes*, Stål."

PIRATES CINGALENSIS.

*Peirates cingalensis*, *Dohrn, Stett. ent. Zeit.* xxi. p. 408, n. 97 (1860).

Described from Ceylon.

PIRATES FUSCICORNIS.

*Peirates fuscicornis*, *Dohrn, Stett. ent. Zeit.* xxi. p. 408, n. 98 (1860).

Described from Ceylon.

\*†PIRATES STIGMATIVENTRIS, sp. n.

Long. corp. 10 millim.

Black; the antennæ, coxæ in great part, base of femora, knees, tibiæ and tarsi, and under surface of abdomen, besides a line running below the rim of the pronotum and below the wings, rufo-testaceous; tegmina abbreviated in the specimens described, black and pointed, hardly extending for more than a third of the length of the abdomen; abdomen above black, with the lateral edges spotted with rufo-testaceous, and two pale spaces at the extremity of the last two dorsal segments, each containing a round black spot; abdomen beneath rufo-testaceous, the colour extending up the median line of the pectus; last two dorsal segments shining black in the middle; spiracles placed on black spots, between each of which are two small black dots; the black colour of the pectus extends round the base of the hind coxæ, where it ceases. Within the rim of the upper surface of the abdomen, and also on the median line, are rows of small, raised, paler dots.

Nitagala.

Allied to *P. fuscicornis*, Dohrn, and to *P. ypsilon* (infra); but differs in the colour of the legs, antennæ, abdomen, &c.

\*†PIRATES YPSILON, sp. n. (Plate IV. fig. 8.)

Long. corp. 13 millim.

Dull black; antennæ testaceous; scape dark reddish brown; scutellum with a Y-shaped carina, the part behind the branches of a more velvety black. Tegmina dull black, with a large testaceous blotch on the middle of the inner margin; inner margin to half the distance to the base, and the centre of the tegmina beyond to the crossing of the nervures (which at this point are slightly testaceous), velvety black. Rostrum shining black, testaceous at the extremity. Abdominal margin spotted with testaceous. Legs testaceous, the base of the coxæ, the trochanters, the front femora, and the basal half of the four hinder femora black; tibiæ blackish above towards the tips.

Allied to the last two species.

Pundaloya. Found under decaying leaves (*E. E. G.*).

PIRATES QUADRINOTATUS.

*Reduvius quadrinotatus*, *Fabr. Ent. Syst. Suppl.* p. 544 (1798).

||*Peirates biguttatus*, *Dohrn, Stett. ent. Zeit.* xxi. p. 407, n. 96 (1860).

Recorded from India and Ceylon.

\*†PIRATES PICTUS.

*Pirates* (?) *pictus*, *Herr.-Schäff. Wanz. Ins.* viii. p. 63, pl. 268. f. 827 (1848).

Recorded from India, China, and Ceylon.

The locality of Mr. Green's specimens is not noted.

EUMERUS INSIGNIS.

*Eumerus insignis*, *Reuter, Act. Fenn.* xii. p. 317 (1881).

Described from Ceylon.

PROSTEMMA CARDUELIS.

*Prostemma carduelis*, *Dohrn, Stett. ent. Zeit.* xix. p. 229, pl. i. f. 8 (1859).

Described from Ceylon.

NABIS CRIBRATICOLLIS.

*Gorpis cribraticollis*, *Stal, Öfv. Vet.-Akad. Förh.* xvi. p. 377 (1860).

Described from Ceylon.

\**ACANTHASPIS QUINQUESPINOSA*.

*Reduvius quinquespinosus*, *Fabr. Spec. Ins.* ii. p. 382, n. 27 (1781).

Recorded from India and Ceylon.

\*†*ACANTHASPIS TERGEMINA*.

*Platymeris tergemina*, *Burm. Handb. Ent.* ii. p. 233, n. 2 (1839).

Recorded from India and Ceylon.

This is either a variable species or else there are several closely allied forms. A good series of the *Acanthaspides* of Ceylon would be very interesting.

Generally found about houses; the larva probably lives among dust and dirt (*E. E. G.*).

\*†*ACANTHASPIS ANGULARIS*.

*Acanthaspis angularis*, *Stål, Öfv. Vet.-Akad. Förh.* xvi. p. 188 (1860).

Described from Ceylon.

Mr. Green's specimen is from Colombo.

\*†*ACANTHASPIS HELLUO*.

*Acanthaspis helluo*, *Stål, Ann. Soc. Ent. France*, (4) iii. p. 50 (1863).

Recorded from India and Ceylon.

The locality of Mr. Green's specimen is not recorded.

\**ACANTHASPIS PICTIPES*.

*Acanthaspis pictipes*, *Walk. Cat. Hem. Het. B. M.* vii. p. 176, n. 52 (1873).

Described from Ceylon.

*ACANTHASPIS BISTILLATA*.

*Acanthaspis bistillata*, *Stål, Öfv. Vet.-Akad. Förh.* xv. p. 443 (1858).

Described from Ceylon.

*ACANTHASPIS FUSCONIGRA*.

*Acanthaspis fusconigra*, *Dohrn, Stett. ent. Zeit.* xxi. p. 407, n. 89 (1869).

Described from Ceylon.

\**REDUVIUS DIVISICOLLIS*.

*Reduvius divisicollis*, *Walk. Cat. Hem. Het. B. M.* vii. p. 197, n. 51 (1873).

Described from Ceylon. The type appears to be a discoloured specimen.

## \*†APECHTIA METAPYRRHA.

*Apechtia metapyrrha*, *Reuter, Act. Fenn.* xii. p. 321 (1881).

Described from Ceylon.

## OPINUS PYRRHUS.

*Lenæus pyrrhus*, *Stål, Öfv. Vet.-Akad. Förh.* xvi. p. 187 (1860).

Described from Ceylon.

## \*†(?) OPINUS RUGICOLLIS.

*Opinus rugicollis*, *Walk. Cat. Hem. Het. B. M.* viii. p. 3 (1873).

Described from Ceylon. Mr. Green's collection contains an immature specimen from Maskaleya which appears to belong to this species.

## CERILOCUS DISCOLOR.

*Cerilocus discolor*, *Stål, Stett. ent. Zeit.* xxii. p. 146 (1861).

Described from Ceylon.

## TIARODES ELEGANS.

*Tiarodes elegans*, *Stål, Ann. Soc. Ent. France*, (4) iii. p. 55 (1863).

Described from Ceylon.

## \*†TIARODES VARICOLOR.

*Tiarodes varicolor*, *Stål, Ann. Soc. Ent. France*, (4) iii. p. 55 (1863).

Recorded from the Philippines, Java, Penang, and Ceylon.

Mr. Green's specimen, which seems to belong to this variable species, is without special locality.

## Genus DICEPHALUS, g. n.

The entire insect sparingly clothed with short diverging hair.

*Head*.—Eyes rounded, very prominent, as broad as the front lobe of the pronotum.

Frontal lobe commencing at the back of the eyes, with nearly parallel sides and subtruncated in front.

Hinder lobe broader and shorter, forming a long oval, very convex above, and with a very large ocellus on each side in front.

Antennæ 4-jointed, rising in a stout oblique process on each side of the frontal lobe; scape thickened, about three times as long as broad; second joint the longest, about four times as long as the scape and fully half as long again as the third joint; fourth joint about as long as the third and pointed at the tip.

Rostrum 4-jointed, short and broad at the base; the last joint conical, pointed.

Pronotum trilobate, each lobe distinctly wider than the preceding; front lobe slightly grooved in the middle; middle lobe more deeply, but not quite to the back, and with a shallow oblique groove on each side.

Scutellum triangular.

Metanotum with a short thick spine at each of the hinder angles.

Abdomen as broad as the hinder lobe of the pronotum, depressed, strongly keeled beneath.

Tegmina moderately long and broad; costa and inner margin nearly straight, the latter slightly oblique; hind margin rounded; costal nervure only indicated at the base, but throwing off a slender hairy line close to, and nearly parallel with, the costa, and curving round so as to enclose a long cell close to the basal half of the costa; subcostal rising just beyond the base and throwing off another slender line enclosing a large cell close to the hinder half of the costa, and then continued as a slender line parallel to the hind margin; the middle of this cell is connected beneath by a short transverse nervure with the upper outer cell formed by the median nervure, which rises near the base and ramifies to form two upper and one lower cell; the upper outer cell throws out two nervures to the hind margin, and is connected by a transverse nervure below with the anal nervure, which latter is continued to the boundary line on the hind margin. The outer nervures are apparently double, from being fringed with short black bristles on each side; towards the costa there are also more scattered black bristles, and the costa and hind margin are also fringed with short hairs.

Wings with the subcostal nervure forming a long cell, from the extremity of which a nervure runs to the hind margin; another nervure descends from the middle of the cell and curves outwards to the hind margin; and there is also a lower simple nervure.

*Legs.*—Front and hind femora slightly thickened and carinated; front tibiae flattened and much widened at the extremity, which is cut off square, and armed with three sharp spines on the lower edge; front tarsi 2-jointed, the terminal joint consisting apparently of one long, sharp, curved spine, but on very careful examination the extremity is seen to consist of two short claws;



middle tibiæ thickened towards the extremity; middle and hind tarsi apparently consisting of one long joint with two claws, but actually 2-jointed.

\*†DICEPHALUS TELESCOPICUS, sp. n. (Plate IV. figs. 14, 14 a.)

Long. corp. 5 millim.; exp. tegm. 10–11 millim.

Varies from chestnut-brown to blackish; head in front of antennæ, rostrum, legs, and abdomen, at least at the sides, rufo-testaceous; coxæ, trochanters, and knees testaceous.

Pundaloya.

This very remarkable little species seems to have been quite overlooked by previous observers, in spite of its abundance.

Found flying in bright sunshine in open glade of jungle near felled timber. Flight sustained; three or four insects found frequently playing together like common flies in a room, or like Ephemeridæ (*E. E. G.*).

\*PETALOCHEIRUS MALAYUS.

Petalochairus malayus, *Stål, Œfv. Vet.-Akad. Förh.* xvi. p. 191 (1860).

Recorded from India, Ceylon, and Pulo Penang.

PETALOCHEIRUS BRACHIALIS.

Petalochairus brachialis, *Stål, Œfv. Vet.-Akad. Förh.* xv. p. 444 (1858).

Described from Ceylon.

\*†CONORRHINUS RUBROFASCIATUS.

Cimex rubrofasciatus, *De Geer, Ins.* iii. p. 349, pl. xxxv. f. 19 (1773).

Common in the warmer parts of both hemispheres.

Mr. Green's specimen is from Nawalapitya.

\*†OPISTOPLATYS INDICUS.

Opistoplatys indicus, *Walk. Cat. Hem. Het. B. M.* viii. p. 20, n. 2 (1873).

Recorded from India and Ceylon.

Mr. Green's specimen is from Hambantotta.

\*†ONCOCEPHALUS CINGALENSIS.

Oncocephalus cingalensis, *Walk. Cat. Hem. Het. B. M.* viii. p. 26 (1873).

Walker's description is taken from a discoloured specimen. Mr. Green's specimens are from Putlam.

## \*ONCOCEPHALUS NABOIDES.

*Oncocephalus naboides*, *Walk. Cat. Hem. Het. B. M.* viii. p. 27, n. 17 (1873).

Described from Ceylon.

## STACCIA PLEBEIA.

*Staccia plebeia*, *Stål, Berl. ent. Zeitschr.* x. p. 166 (1866).

Described from Ceylon.

## \*SASTRAPADA BIPUNCTATA.

*Sastrapada bipunctata*, *Walk. Cat. Hem. Het. B. M.* viii. p. 28, n. 7 (1873).

Described from Ceylon.

## CANTHESANCUS TRIMACULATUS.

*Canthesancus trimaculatus*, *Amyot & Serv. Ins. Hémipt.* p. 389, pl. vii. f. 20 (1843).

Included in Dohrn's list as Cinghalese ; but originally described from Java. Dohrn's specimens may have belonged to *C. helluo*, *Stål*.

## \*CANTHESANCUS HELLUO.

*Canthesancus helluo*, *Stål, Ann. Soc. Ent. France*, (3) iii. p. 44 (1865).

Described from Ceylon.

## CANTHESANCUS FALLENI.

*Theodelmus Falleni*, *Stål, Öfv. Vet.-Akad. Förh.* xvi. p. 378 (1860).

Described from Ceylon.

## PYGOLAMPIS FÆDA.

*Pygolampis fæda*, *Stål, Öfv. Vet.-Akad. Förh.* xvi. p. 379 (1860).

Described from Ceylon.

## \*†ECTRICHODIA LINNEI.

*Ectrichodia Linnei*, *Stål, Öfv. Vet.-Akad. Förh.* xvi. p. 178 (1860).

*Ectrichodia discrepans*, *Walk. Cat. Hem. Het. B. M.* viii. p. 46, n. 33 (1873).

Recorded from India and Ceylon.

Mr. Green's specimen has no locality label.

## \*†SCADRA FUSCICRUS.

*Scadra fuscicrus*, *Stål, Öfv. Vet.-Akad. Förh.* xvi. p. 183 (1860).

Described from Ceylon.

## SCADRA ANNULICORNIS.

*Scadra annulicornis*, *Reuter, Act. Fenn.* xii. p. 309 (1881).

Described from Ceylon.

## \*†SCADRA CINCTICORNIS, sp. n.

Long. corp.  $12\frac{1}{2}$  millim.

Coral-red; antennæ black, setose, second and third joints with a yellow ring just beyond the base; head and pronotum rugose; pronotum laterally striated and with the crossing and lateral grooves rather deep, but the median depression ceasing before the extremity, and the cross grooves ceasing before the median depression; a black spot on each of the hind lobes of the pronotum, a large spot on the inner angle of the corium like an obtuse-angled triangle with its acute angles truncated; the membrane, the tibiæ, and last joint of the tarsi all black; femora red, basal joints of tarsi and claws pale yellow; ventral surface of abdomen with a row of five rather large black spots in the middle and one on each side, the last three spots of the lateral rows confluent.

Closely allied to *S. fuscicrus*, Stål, from which the banded antennæ and much more coarsely punctured pronotum are amply sufficient to distinguish it.

## \*ANTIOPA PUMILA.

*Antiopa pumila*, *Stål, Ann. Soc. Ent. France*, (4) iii. p. 47 (1863).

Described from Ceylon.

## LARYMNA PILICORNIS.

*Reduvius pilicornis*, *Fabr. Mant. Ins.* ii. p. 311, n. 29 (1787).

Recorded from India, Ceylon, and Sumatra.

## \*†SYCANUS COLLARIS.

*Reduvius collaris*, *Fabr. Spec. Ins.* ii. p. 380, n. 15 (1781).

A common species in South-eastern Asia.

## SYCANUS RECLINATUS.

*Sycanus reclinatus*, *Dohrn, Stett. ent. Zeit.* xx. p. 98 (1859).

Described from Ceylon.

## \*†SYCANUS (?) MILITARIS, sp. n.

Long. corp. 21 millim.

Red, very hairy; antennæ except at base, tibiæ except at base, tegmina except a portion of the costal margin near the base, and

the whole of the under surface of the abdomen except the lateral margins, black or blue-black; the tip of the rostrum and the pleura are also marked with blackish. Front lobe of pronotum very uneven, and with a wide groove in the middle; hind lobe very coarsely granulated, lateral margins strongly expanded, but not pointed or spined.

The head is a little shorter than in typical *Sycanus*.

Putlam.

*HARPACTOR NIGRORUBER.*

Reduvius (*Harpactor*) *nigroruber*, *Dohrn, Stett. ent. Zeit.* xxi. p. 406 (1860).

Described from Ceylon.

\*†*HARPACTOR BICOLORATUS*, sp. n.

Long. corp. cum tegm. 11 millim.

Red and black, hairy; head red, the following parts black:—the antennæ, rostrum above, and last joint, a central streak running backwards from the rostrum and diminishing between the eyes to a mere line, but followed by a broad band covering the whole of the occiput except a narrow lateral line; there is also a slender black line running backwards on the sides of the head behind each eye. Thorax red; all the sutures, the greater part of the front of the hinder lobe of the pronotum, except at the margins, and a great part of the pleura and pectus, black; legs black, coxæ red, marked with a black spot. Scutellum black, the apex red. Tegmina blue-black, iridescent; the costa of the corium broadly red. Abdomen red, the sutures on the ventral surface rather broadly black, and a black central line on the terminal segment beneath.

Probably allied to *Harpactor nigroruber*, Dohrn.

Hambantotta.

*HARPACTOR SORDIDEPENNIS.*

Reduvius (*Harpactor*) *sordidepennis*, *Dohrn, Stett. ent. Zeit.* xxi. p. 406 n. 80 (1860).

Described from Ceylon.

\*†*HARPACTOR OBSCURUS*, sp. n.

Long. corp. 9–10 millim.

Dull brown, with a slight æneous shade, especially on the tegmina; under surface darker; basal joint of antennæ and hind

tibiæ (except a black ring at the base of the latter) reddish; femora and four front tibiæ spotted and streaked with testaceous; abdomen black, lateral margins broadly spotted with testaceous, and there is also at least one row of smaller testaceous spots on each side of the abdomen.

Much resembles the Chinese *H. impressicollis*, Stål, but smaller, and with the pale markings less distinct.

Pundaloya.

*ALCMENA ANGUSTA.*

*Alcmena angusta*, Stål, *Æfv. Vet.-Akad. Förh.* xvi. p. 195 (1860).

Described from Ceylon.

*ENDOCHUS ALBOANNULATUS.*

*Endochus alboannulatus*, Stål, *Æfv. Vet.-Akad. Förh.* xvi. p. 194 (1860).

Described from Ceylon.

\*†*ENDOCHUS CINGALENSIS.*

*Endochus cingalensis*, Stål, *Stett. ent. Zeit.* xxii. p. 135 (1861).

♀. *E. consors*, Stål, *l. c.* (1861).

Common in Ceylon.

Frequents cinchona-trees; a pair taken *in coitû*, proving *E. consors* to be the same species (*E. E. G.*).

Mr. Green's collection contains a single specimen of an allied species, uniform rufo-testaceous in colour; but it is not in sufficiently good condition to describe.

*RIHIRBUS TROCHANTERICUS.*

*Rihirbus trochantericus*, Stål, *Stett. ent. Zeit.* xxii. p. 132 (1861).

Described from Ceylon.

*EUAGORAS FUSCISPINUS.*

*Euagoras fuscispinus*, Stål, *Æfv. Vet.-Akad. Förh.* xxii. p. 135 (1861).

*Darbanus fuscispinus*, Stål, *Æfv. Vet.-Akad. Förh.* xvi. p. 194 (1860).

Described from Ceylon.

*MYOCORIS GILVUS.*

*Myocoris gilvus*, *Burm. Trans. Ent. Soc. Lond.* ii. p. 104 (1837-1840).

Recorded from Java, Sumatra, and Ceylon.

## Genus FORMICORIS.

Head extending for about half its length in front of the eyes, in a broad truncated cone; eyes very prominent, ocelli very small, placed on the vertex nearly opposite the hind border of the eyes; head with the postocular part narrowed obliquely, and then forming a short and very distinct neck; antennæ nearly as long as the body, slender, situated on the sides of the upper part of the head, halfway between the eyes and the extremity, slender; the scape about as long as the breadth of the head; third joint twice as long as the scape, second slightly longer than the third, fourth slightly curved and nearly as long as the second and third together. Rostrum stout, extending as far as the hind coxæ. Thorax spinose, rounded in front. Legs long and slender, unarmed; tarsi 3-jointed; claws bifid. Tegmina rudimentary. Abdomen subglobose, pointed at each end, much wider than the head or thorax, with the lateral edges raised and extremely prominent.

I cannot fix the exact affinities of this remarkable insect; but I place it provisionally near *Myocoris*, which it resembles in the form of the head. It is undoubtedly one of the *Reduviidæ*, and is of extreme interest on account of its extraordinary resemblance to the black spiny arboreal ants of the genus *Hoplomyrmus*, Gerst. (*Polyrhachis*, Smith), so common in the East Indies. *F. inflatus*, or a closely-allied species, seems to be common in all parts of India, as well as in Ceylon (*cf.* Proc. Ent. Soc. Lond., July 1891).

FORMICORIS INFLATUS, sp. n. (Plate IV. figs. 17, 17 a.)

Long. corp. 7 lin.

Dull black, coriaceous, very finely pubescent; tegmina abbreviated, not extending beyond the contracted base of the abdomen, longitudinally ridged, and with very large punctures between, the outer tips whitish. Thorax with a strong spine on each side at the base of the tegmina, and a third rising between them at the tip of the scutellum. Tarsi whitish, the last joint on the four hind legs darker. Abdomen smooth, shining, slightly iridescent, sericeous (red in an immature specimen). The last joint of the antennæ testaceous.

Nitagala.

ZELUS ARMATISSIMUS.

*Polididus armatissimus*, Stål, *Æfö. Vet.-Akad. Förh.* xvi. p. 376 (1860).

Described from Ceylon.

## \*†ISANTHA ARMIPES.

Harpactor armipes, *Stål, Efv. Vet.-Akad. Förh.* xii. p. 189 (1855).

Isantha armipes, *Stål, Stett. ent. Zeit.* xxii. p. 138 (1861).

Described from Ceylon.

## SINEA HOPLITES.

Sinea hoplites, *Dohrn, Stett. ent. Zeit.* xxi. p. 405, no. 74 (1860).

Described from Ceylon.

## SINEA JAVANENSIS.

Sinea javanensis, *Amyot & Serv. Ins. Hémipt.* p. 376 (1843).

Included in Dohrn's list as Cinghalesè.

## SINEA PELTASTES.

Sinea peltastes, *Dohrn, Stett. ent. Zeit.* xxi. p. 406 (1860).

Described from Ceylon.

## EMESIDÆ.

## \*†PLOCARIA OCULATA.

Plocaria oculata, *Reuter, Act. Fenn.* xii. p. 338 (1881).

Described from Ceylon.

Mr. Green's specimen is from Nitagala.

## GARDENA MELANARTHURUM.

Gardena melanarthrum, *Dohrn, Linn. Ent.* xiv. p. 214 (1860).

Described from Ceylon.

## EMESA HENRICI.

Emesa Henrici, *Dohrn, Linn. Ent.* xiv. p. 218 (1860).

Described from Ceylon. Dohrn speaks of this species as the slenderest of all insects.

## EMESA INVISIBILIS.

Emesa invisibilis, *Dohrn, Linn. Ent.* xiv. p. 219, pl. i. f. 7 (1860).

Described from Ceylon.

## GERRIDÆ.

## GERRIS NITIDA.

Hydrometra nitida, *Mayr, Verh. zool.-bot. Ges. Wien*, xv. p. 443 (1865)

Described from Ceylon.

## \*†GERRIS PECTORALIS.

Hydrometra pectoralis, *Mayr, Verh. zool.-bot. Ges. Wien*, xv. p. 443 (1865).

Described from Ceylon.

Mr. Green's specimens of this species are from Pundaloya; but most of his water-bugs are from Nitagala, Pundaloya being rather dry.

GERRIS ARMATA.

Gerris armata, *Spin. Essai sur les Ins. Hém.* p. 65 (1837).

Described from Ceylon.

GERRIS ADELAIDIS.

Gerris Adelaidis, *Dohrn, Stett. ent. Zeit.* xxi. p. 408, n. 105 (1860).

Described from Ceylon.

\*†CYLINDROSTETHUS FIEBERI.

Cylindrostethus Fieberi, *Mayr, Verh. zool.-bot. Ges. Wien*, xv. p. 444 (1865).

Described from Ceylon.

Mr. Green's specimen is from Nitagala.

\*†PTILOMERA LATICAUDATA.

Gerris laticaudata, *Hardw. Trans. Linn. Soc. Lond.* xiv. p. 134, pl. vi. f. 1-4 (1825).

Ptilomera cingalensis, *Stål, Öfv. Vet.-Akad. Förh.* xii. p. 190 (1856).

Mr. Green's specimens are from Pundaloya.

HALOBATES STÅLI.

Halobates Ståli, *Dohrn, Stett. ent. Zeit.* xxi. p. 408, n. 103 (1860).

Described from Ceylon.

HALOBATES BREVIS.

Metrocotis brevis, *Mayr, Verh. zool.-bot. Ges. Wien*, xv. p. 445 (1865).

Described from Ceylon.

NEPIDÆ.

\*†BELOSTOMA INDICA.

Belostoma indica, *St.-Farg. & Serv. Encycl. Méth.* x. p. 272 (1825).

Common throughout the warmer parts of the Old World.

\*†DIPLONYCHUS RUSTICUS.

Nepa rustica, *Fabr. Syst. Ent.* p. 691, n. 2 (1775).

Common throughout the East Indies.

\*†NEPA RUBRA.

Nepa rubra, *Linn. Syst. Nat.* i. p. 440, n. 2 (1758).

Common throughout the East Indies.

NEPA FLAVOVENOSA.

Nepa flavovenosa, *Dohrn, Stett. ent. Zeit.* xxi. p. 409 (1860).

Described from Ceylon.



## \*†NEPA MACULATA.

*Nepa maculata*, *Fabr. Syst. Ent.* p. 692, n. 5 (1775).

An East-Indian species, not previously recorded from Ceylon. Mr. Green's specimens are from Nitagala.

## \*†RANATRA SORDIDULA.

*Ranatra sordidula*, *Dohrn, Stett. ent. Zeit.* xxi. p. 409 (1860).

Several specimens, collected by Mr. Green at Nitagala, in the North Central part of Ceylon, where water-bugs were more plentiful than at Pundaloya. None of the specimens are quite so large as the dimensions given by Dohrn.

## \*†CERCOTMETUS ASIATICUS.

*Cercotmetus asiaticus*, *Serv. Ins. Hém.* p. 441 (1843).

Recorded from Java and Mount Ophir (Malacca). Mr. Green's specimen is from Nitagala.

## \*†NAUCORIS (?) PUNCTATISSIMA.

Long. corp. 7 millim., lat. 4 millim.

Rufo-testaceous, very thickly punctured; eyes black, with a yellow line behind; pronotum with two longitudinal impressions in the middle, and one in front, and often with a black line on the hind border; scutellum black; corium reddish brown or blackish, the costa broadly rufo-testaceous or yellowish, and there is frequently a detached yellow spot near the middle. Membrane blackish. Under surface blackish, except the margins, the legs, and the middle of the under surface of the head and abdomen.

Appears to be common in Ceylon. The extremely thick punctuation and the depressions on the thorax give it almost a rugose appearance. It is narrower than the other species of the genus.

Pundaloya.

Found on wet rocks by running water (*E. E. G.*).

## \*NOTONECTA SIMPLEX, sp. n.

Long. corp. 11–11½ lin.

Testaceous; face, under surface, and legs more inclining to reddish; a deep oval black depression behind each eye; pronotum with a blackish transverse band towards the under edges; the front of the scutellum sometimes blackish; wings apparently black, and showing through the membrane and part of the corium; a black spot sometimes visible near the outer extremity of the corium.

Allied to *N. lutea*, Müll.

Ceylon. Received from Dr. Templeton.

## \*NOTONECTA TEMPLETONII, sp. n.

Long. corp. 10 millim.

Much resembles *N. simplex*, but smaller and darker. Testaceous; face, legs, and under surface more inclining to reddish; black postocular spots smaller and rounder than in *N. simplex*; pronotum with a reddish or blackish transverse band in front, and traces of a dusky band behind; scutellum more or less blackish in front; corium testaceous, with three black bands, the first covering nearly the whole of the basal area, and the second covering the whole of the central area between the two black veins, except at the base; the space between these bands is also filled up with black at the extremity; the third band is formed by a long black spot towards the outer margin of the extremity of the corium. Wings showing through the membrane black.

Ceylon. Received from Dr. Templeton.

## \*†NOTONECTA ABBREVIATA, sp. n.

Long. corp. 8 millim.

Testaceous; vertex slightly darker, postocular depression only marked with one or two inconspicuous black dots; pronotum and scutellum black, the latter widely bordered with testaceous on the sides; corium with the basal half of the tegmina and the costa (narrowly) testaceous; the outer half blue-black, this colour extending further towards the base on the median area (where it ends in a concavity on the basal side) than nearer the margins. Wings showing black through the membrane.

In Dr. Templeton's and Mr. Green's (Nitagala) collections. Probably allied to *N. indica*, Fabr., from Sumatra.

## CORIXIDÆ.

## CORIXA ALBIFRONS.

*Corixa albifrons*, Motsch. *Bull. Mosc.* xxxvi. (3) p. 94 (1864).

Described from Ceylon (Colombo).

## HEMIPTERA HOMOPTERA.

## CICADIDÆ

How much remains to be done in Entomology, even among the larger species of insects, may be seen from the fact that only 7 species of Cicadidæ were known from Ceylon before

Mr. Green's visit. He obtained 9 species in all, of which 4 are new, thus raising the present number to 11.

\*†PÆCILOPSALTRIA SUBRUFÆ.

*Oxypleura subrufa*, *Walk. List Hom. Ins. B. M. i. p. 25, n. 7* (1850).

*Pseudopsaltria subrufa*, *Dist. Mon. Or. Cic. p. 9, pl. i. f. 1 a, b* (1889).

A rather scarce species, recorded from India and Ceylon.

No locality noted by Mr. Green.

\*†PÆCILOPSALTRIA OCTOGUTTATA.

*Tettigonia 8-guttata*, *Fabr. Ent. Syst. Suppl. p. 515* (1798).

*Pæcilopsaltria octoguttata*, *Dist. Mon. Or. Cic. p. 10, pl. i. f. 5 a, b* (1889).

Common in all parts of India. The specimen obtained by Mr. Green (without special locality) is the largest on record, measuring no less than 88 millim. in expanse of tegmina. Mr. Distant gives the dimensions as 73 to 80 millim.; but the range is greater, as the smallest example in the Museum measures only 68 millim.

\*†PÆCILOPSALTRIA WESTWOODI.

*Platycleura Westwoodii*, *Stål, Trans. Ent. Soc. Lond. (3) i. p. 571* (1863).

*Pæcilopsaltria Westwoodii*, *Dist. Mon. Or. Cic. p. 15, pl. i. f. 18 a, b* (1889).

A very pretty species, confined to Ceylon. The wings are dark brown with reddish nervures, and the hind margin is orange, as well as a broad band, bending outwards and irregular in its outline, which runs from the costa nearly across the dark part of the wing. The inner marginal fold is dark brown, with a very narrow grey edging.

Mr. Green's specimens are from Kandy.

\*†COSMOPSALTRIA LARUS.

*Dundubia larus*, *Walk. List Hom. Ins. B. M. Suppl. p. 7* (1858).

*Cosmopsaltria larus*, *Dist. Mon. Or. Cic. p. 44, pl. v. f. 1 a, b, pl. iv. f. 18* (1889).

Common in India and Ceylon. Closely allied to the Indian *C. vibrans*, *Walk.*, but smaller, and rather more heavily marked.

Mr. Distant has pointed out that this is the insect figured by Sir Emerson Tennent under the name of the "Knifegrinder" in his 'Natural History of Ceylon,' p. 432.

## \*†DUNDUBIA STIPATA.

*Dundubia stipata*, *Walk. List Hom. Ins. B. M. i. p. 51* (1850).

♂. *D. clonia*, *Walk. l. c. p. 66* (1850).

Described from Ceylon. Mr. Green's specimens are from Kandy.

## \*†DUNDUBIA MIXTA, sp. n.

Long. corp. 30 millim.; exp. tegm. 97 millim.

*Female*. Head black; body mostly black above and ferruginous below; sericeous. Head, especially on the back and face, covered with white pubescence, and with the following reddish markings:—two spots at the back of the vertex, obliquely behind the two hinder ocelli, each enclosing a black dot, two short stripes on each side in front of the vertex, and two spots below each, between the eye and the projecting lateral angle of the vertex; a triangular spot on the upper part of the face, soon followed by a stripe, broad above and narrow below, on the median line; the lateral ridges of the face (narrowly reddish, the space between sericeous); the base of the clypeus in the middle and a cone on the median line running from it; and the rostrum, except the tip and a line on the upper surface, which are black. The pronotum has a broad reddish stripe in the middle of the front lobe; the hind lobe is greenish, the lateral curved carina being reddish, running from the black portion of the pronotum, and marked with black behind; the propectus is black in the middle and rufo-testaceous on the sides, and densely pubescent. Mesonotum black, with two reddish or rufo-testaceous stripes, broadest behind, and extending in a point to the front margin; the lateral margins are rufo-testaceous, clothed with gilded pubescence; and the cruciform elevation is rufo-testaceous, the lateral depressions being greenish. Abdomen black above, densely clothed on the sides of the three basal segments with white pubescence, of which faint traces are also seen on the following; the sixth segment has a narrow rufo-testaceous line, interrupted in the middle, at the extremity. Pleura rufo-testaceous; pectus mostly blackish in the middle; abdomen beneath rufo-testaceous, laterally bordered with white pubescence; ovipositor darker; terminal segment black on each side at the extremity and densely hairy; two small reddish spots on each side of the ovipositor on the black part of the terminal segment. Legs red; in the front pair, the base of the coxæ, the under surface of the femora, and all the tibiæ and tarsi, except the basal half of the former above, are

black; the four hinder legs are also marked with black, but less extensively. Front femora slightly thickened, with two very long spines on the under surface, one near the base, and the other at three-fourths of the length; just beyond the second is another small tooth. A small pectoral spine just in front of the insertion of the tegmina, which are hyaline, with the costal area to beyond the radial area rufo-testaceous; beyond this, the subcostal area, though surrounded by blackish nervures, is also rufo-testaceous; basal area green; nervures rufo-testaceous towards the base, darker towards the margins; the second apical area projecting distinctly beyond the others. Wings hyaline, green at the base, nervures brown, the costal and two others of the principal nervures being pale, especially towards the base.

Not closely allied to any other species before me. I regret that I have only a single specimen to describe from.

Exact locality not recorded.

#### POMPONIA RANSONNETI.

*Pomponia Ransonneti*, *Dist. Ann. Nat. Hist.* (6) i. p. 372 (1888); *Mon. Or. Cic.* p. 72, pl. vii. f. 20 *a*, *b* (1890).

Described from Ceylon.

#### \*†POMPONIA GREENI, sp. n. (Plate V. fig. 11.)

Long. corp. 23 millim.; exp. tegm. 65 millim.

*Male*. Green and reddish brown, the greater part of the insect clothed with pale gilded or silvery pubescence.

Head and thorax green; pectus and pleura whitish with pubescence; vertex with the whole centre black, this colour branching out in front between the eyes and the upper part of the face; a yellow dash at the back of the vertex, and one on each side of, but not adjoining, the front ocellus; face with a green triangle at its base, below which the centre is black, broadly at first, but afterwards diminishing; in the middle of the broad black upper part is a large oval yellow spot, and a little below it is a short yellow dash; there is a smaller oval spot in the middle of the clypeus, which is largely black on each side of it; rostrum yellow. Pronotum green, with a yellower stripe not quite reaching the extremity, and surrounded with black, broadly in front, and more narrowly behind, the broadest point being contiguous with a black figure of 8 marking on each side, beyond which again is a black dot. Mesonotum green, with a

central black stripe, connected at the base with a band of half the length on each side, extending half across the pronotum, and angulated out on each side, the intermediate space being buff. Beyond this is another buff space on the front edge, in the middle of which stands a short black streak, followed by a long black band, edged on each side with buff, especially in front, and nearly touching two large spots which stand at the hinder edge of the mesonotum, on each side of the central streak. There is also a short black oblique streak on each side of the mesonotum, at the front margins; and other black markings along the lateral sutures; a yellow or buff spot on the summit of the cruciform space. Abdomen reddish brown, sericeous, the lateral margins obscurely spotted with greenish; the sutures, stigmata, and apical segment blackish. Ventral surface with the front edge of the abdomen and the terminal segment blackish; legs greenish, femora streaked with black and reddish; tip of femora and base of tibiæ with black rings, front tibiæ varied with buff and blackish; front tarsi black; tips of other tibiæ and tarsi inclining to buff. Tegmina hyaline, nervures mostly red, those at the base green; at the extremity of the radial area is a pale space, before and behind which the nervures are black; the membrane is also edged above by a black vein below a red one, and in one or two other parts of the wing the veins shade into black; on the first branch of the nervure bounding the radial area below is a singular black pointed widening of the nervure on each side, at about one third of its length from the fork. There is a brown spot at the extremity of the three upper ulnar areas, and six submarginal spots near the extremities of the marginal nervures.

In one specimen the wings are beautifully iridescent, which is not the case to anything like the same extent in the others.

Pundaloya and Hematelta.

Possibly allied to *P. Ransonneti*, Dist., also from Ceylon, but which I only know from the description; *P. Ransonneti*, however, seems to be a much larger insect, and less brightly coloured.

Only met with at a very high elevation (*E. E. G.*).

\*†*POMPONIA ELEGANS*, sp. n.

Long. corp. 31 millim.; exp. tegm. 68 millim.

*Male*. Green, clothed with gilded or silvery-white scale-like

pubescence. Head in the immediate neighbourhood of the ocelli black. Pronotum with a green stripe on the middle, entirely surrounded with a brown border, which somewhat resembles a wine-glass in shape; this is bordered with green, but the two oblique lobes on each side beyond are brown. Scutellum green, with three broad brown stripes in the middle, united at the base, the central one extending to the cruciform appendage, and the outer ones only half as far; beyond these, on each side, is a broad irregular stripe curving outwards, and on reaching the borders of the scutellum extended outwards as a black edging for a short distance, and inwards as far as the cruciform appendage, before each front angle of which stands a black spot, the cruciform appendage itself being yellowish. Abdomen covered with deep golden pubescence, with more or less silvery pubescence on the sides and towards the middle of the segments; on the terminal segments and beneath it is whiter. Tegmina greenish hyaline; costa and basal cell green, the latter edged below with a brown nervure as far as the radial area extends; nervures mostly green, interrupted with black spaces towards the base, costa, and middle; towards the apex they are brown. All the cross-nervures and most of the forks of the nervures are marked with fuscous spots, and there is a row of submarginal fuscous spots on the nervures within the apical areas, which run very regularly. Membrane white. Wings hyaline, with greenish nervures and white membrane. Legs ferruginous brown, hind legs more green; front femora incrassated, with two not very large teeth; hind tibiæ with three short spines. Rostrum black at the tip, extending rather beyond the hind coxæ; drums divergent at the extremity, and extending to the end of the first segment of the abdomen.

Kandy.

Not closely allied to any other species before me.

\**CICADA NUBIFURCA*.

*Cicada nubifurca*, *Walk. List Hom. Ins. B. M., Suppl.* p. 28 (1858).

Described from Ceylon.

\*†*CICADA APICALIS*, sp. n. (Plate V. fig. 1.)

Long. corp. 12–14 millim.; exp. tegm. 34–42 millim.

*Female*. Dull reddish brown, with greyish pubescence; the head, the middle and sides of the pronotum and scutellum, and

the base of the abdomen and of its terminal segment dull yellowish green; under surface yellowish testaceous, a blackish stripe on the outside of the front tibiæ; front femora with three very large spines; hind tibiæ with three small ones. Wings hyaline, with brown nervures; tegmina with the basal cell clear, a brown spot at the apex of the wing, and the cross nervures closing the two upper ulnar areas likewise more or less distinctly marked with brown; costa and membrane dull yellow; wings hyaline, the lower internal area brown, hyaline at the tip, and the upper area hyaline, brown at the tip.

Closely allied to *C. nubifurca*, Walk., but distinguished at once by the brown apical spot.

Kandy and Aviswella (July 1888).

#### FULGORIDÆ.

##### \*† HOTINUS MACULATUS.

Fulgora maculata, *Oliv. Encycl. Méth.* v. pp. 563, 568, n. 5 (1790).

Mr. Green's specimen has no locality label.

##### \*HOTINUS FULVIROSTRIS.

Hotinus fulvirostris, *Walk. List Hom. Ins. B. M., Suppl.* p. 41 (1858).

Described from Ceylon.

Perhaps a variety of the last species.

##### \*†HOTINUS COCCINEUS.

Hotinus coccineus, *Walk. List Hom. Ins. B. M., Suppl.* p. 42 (March 1858).

Hotinus guttifer, *Stål, Æfö. Vet.-Akad. Förh.* xv. p. 448 (Nov. 1858).

Seems to be a common species in Ceylon and rather variable.

Mr. Green's specimens are from Kandy, Dambool, and Putlam.

##### \*† HOTINUS INSULARIS, sp. n. (Plate VI. fig. 4.)

Long. corp., absque caput, 14 millim.; caput cum proc. 16 millim.

Buff or brown, speckled with black; abdomen black above; tegmina rufous-brown, with pale spots; wings orange, bordered with black. Head with the protuberance brown, rather large and long for the size of the insect, waved beyond the middle, and curved rather suddenly upwards at the apex; apex, which is smooth and shining, yellowish. Under surface with three



yellowish carinæ extending to the tip; two other carinæ run below the eyes and extend nearly to the tip, where they unite with two others, running between the eyes on the vertex, converging rapidly to the middle of the length of the protuberance, and then running subparallel till they meet those running below the eyes, at their termination before the tip. Another carina runs on the median line above between the others for a short distance. The head, thorax, and legs are buff, speckled and reticulated all over with black; there is a conspicuous black spot on a buff ground in front of each eye. Abdomen black above; ventral surface and under surface of legs clearer buff, much more sparingly and distinctly spotted with black; a red spot on each side of the last ventral segment of the abdomen. Tegmina rufous-brown, with brown nervures, which become reddish towards the tips; they are marked with obsolete dusky spots towards the margins, and with numerous pale spots on the disk. On the under surface the tegmina are redder, and the pale spots are distinctly red. Wings orange, shading into red on the costa, and with a broad border, which is black towards the inner margin, and fusco-hyaline, with red nervures, towards the apex.

Allied to *H. coccineus*, but abundantly distinct.

Dambool.

\*†PYROPS AFFINIS.

*Fulgora affinis*, *Westw. Trans. Linn. Soc. Lond.* xviii. p. 144, n. 18, pl. xii. f. 6 (1841).

*Pyrops Dohrni*, *Stål, Œfv. Vet.-Akad. Förh.* xv. p. 449 (1858).

||*Fulgora punctata*, *Gray, Griffith's Anim. Kingd.* xv. pl. xc. f. 1 (1832).

*Pyrops punctata*, *Walk. List Hom. Ins. B. M.* ii. p. 268, n. 3 (1851).

Common in the East Indies.

Colombo, Oct. 1887 (*E. E. G.*).

\*†APHANA SANGUINALIS.

*Aphana sanguinalis*, *Westw. Ann. Nat. Hist.* (2) vii. p. 208 (1851).

Described from Ceylon. Prof. Westwood describes the rostrum as black; but it is red in Mr. Green's specimen, which is without special locality.

\*†DICHOPTERA HYALINATA.

*Fulgora hyalinata*, *Fabr. Syst. Ent.* ii. p. 315, n. 12 (1781).

Common in India and Ceylon. Mr. Green's specimens are from Kandy.

## \*STACOTA BREVICEPS. :

Dictyophora breviceps, *Walk. List Hom. Ins. B. M., Suppl.* p. 68 (1858).

Described from Ceylon.

## STACOTA COMPTELLA.

Stacota comptella, *Stål, Berl. ent. Zeitschr.* iii. p. 325 (1859).

Described from Ceylon.

## \*†STACOTA RUFITARSIS, sp. n.

Long. corp.  $8\frac{1}{2}$  lin.; exp. tegm. 22 lin.

*Female.* Grass-green; the sutures of the head and thorax, the tarsi, and the spines of the hind tibiæ reddish; clypeus with a red transverse line at the summit, from which descend three red lines, one central, the others submarginal; claws and a line on the front tibiæ blackish; tegmina subhyaline, slightly clouded towards the hind margin; nervures green, pitchy in the submarginal area, which is edged outside by a yellowish line; wings clear hyaline, with pitchy nervures; costal nervure green; a black spot on the pleura, just below the base of the wings.

A pretty species, larger than either of those previously described. It seems to be nearest allied to *S. comptella*.

Pundaloya.

## \*†DICTYOPHORA ALBIVITTA.

Dictyophora albivitta, *Walk. List Hom. Ins. B. M.* ii. p. 319, n. 34 (1851).

Described from Bengal. The specimens from Ceylon are darker than the type (which is perhaps somewhat faded), but appear to belong to the same species.

## \*†DICTYOPHORA PERCARINATA, sp. n.

Long. corp. 11 millim.; exp. al. 18–20 millim.

Head and thorax red or yellowish, with bright green carinæ; head about one fourth longer than from its base to the end of the scutellum; process with the extreme tip dusky; two lateral carinæ above, and the commencement of a central one at the base; beneath green, with two red lines near the middle. Pronotum and scutellum each with five green carinæ; sides of prothorax with a green carina behind each eye. Abdomen green, with a row of black spots above on the central line; legs rufo-testaceous, coxæ and tarsi blackish; hind tibiæ greenish, armed with three spines. Tegmina and wings hyaline, with green

nervures, darker towards the hind margin; stigma clouded towards the costa, and enclosing four transverse nervures.

Allied to *D. pallida*, Walk. Appears to be a common species in Ceylon.

Putlam.

\*†*Dictyophora viridistigma*, sp. n.

Long. corp. 8 lin.; exp. tegm. 20 millim.

Head pointed in front, but only twice as long as the eyes, and with no horn. Head and thorax lined with bright green and red; vertex with a red central and two lateral stripes running between the eyes, and continued on the face to the base of the rostrum; sides of head yellowish, antennal tubercles dull green. Prothorax with a green central carina, a green band extending behind the eyes to the red tegulæ, and the sides green. Mesonotum bright green; abdomen and under surface dull yellowish green, with one or two brighter green markings under the wings; legs rufo-testaceous, with more or less of the femora and tibiæ green. Tegmina and wings clear hyaline, with brown nervures, the former with the costa and inner margin very narrowly bordered with red; stigma very large, green, crossed by two veins in the middle.

Not closely allied to any described species.

Pundaloya.

\*†*Dictyophora* (?) *egregia*, sp. n. (Plate V. fig. 4.)

Long. corp. 19 millim.; cap. cum cornu, 9 millim.; exp. tegm. 28 millim.

Dull brown, speckled with black; apex of metanotum green; abdomen varied with testaceous yellow. Tegmina brownish hyaline, with two brown spots, one on the stigma, and one at the apex; wings clear hyaline, with a brown shade at the extremity. Underside paler, a line below the wings and the lateral abdominal carinæ black; legs greenish, tarsi reddish, claws and spines on hind tibiæ black; femora dotted with black. Head and frontal protuberance of a very remarkable shape; mesonotum produced behind in a truncated cone, tricarinate, the carinæ continued over the pronotum, and the two lateral ones running forward on the head between the eyes. Eyes long, oval; head continued, with the sides nearly parallel, about one and a half times as far beyond, and then suddenly constricted. The horn

is more than twice as long as the part of the head already described; on the upper side are two lateral diverging carinæ, so that its apex is broader than its base. On the lower surface the head is continued so far back that the base of the rostrum (which extends as far as the middle of the abdomen) lies just in front of the anterior coxæ. At this point the head is tricarinate, but below the eyes the lateral carinæ are angulated outwards, and gradually disappear towards the base of the horn. At this point, too, is a long double carina in the middle, ending in a point at the base of the horn. Here rises another double carina, longer and narrower than the first, meeting in a point at both ends, and extending just beyond the expanded upper part of the rostrum.

Not closely allied to any known species.

Pundaloya.

Genus SYMPLANA, g. n.

Resembles *Dictyophora*, but with very different neurulation.

Head and thorax above with a wide depression on the median line; head curved up beyond the eyes, the end of the frontal prominence pointed, as seen from the side; face very long, with five carinæ. Tegmina rather long and narrow, vitreous, with longitudinal simple nervures; at about five-sixths of their length they are crossed by transverse nervures (not extending to the last space on the inner margin), and then by a straight nervure quite across, so that a row of three (or, by bifurcation, four) cells is formed, running from the costa nearly across the wing; beyond these, the upper nervures are forked towards the costa at and before the tip. Legs simple, rather long and slender.

\*†SYMPLANA VIRIDINERVIS, sp. n. (Plate VI. fig. 11.)

Long. corp. cum tegm. 7–8 millim.

Green, brighter above, and inclining to yellowish below, the wide groove on the head and thorax above, and a slender line on the inner margin of the tegmina, bright scarlet; tegmina hyaline, with green nervures; wings hyaline; claws black.

A very delicately formed and coloured species, which does not seem to be uncommon in Ceylon.

Pundaloya.

\*†OSSA DIMIDIATA.

*Ossa dimidiata*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 107, pl. ii. f. 23 (1863).

A single very poor specimen in Mr. Green's collection.

Mount Patannas (*Motschulsky*); Pundaloya (*Green*).

## CIXIIDÆ.

\*†CIXIUS NUBILUS. (Plate V. fig. 13.)

*Cixius nubilus*, *Walk. List Hom. Ins. B. M., Suppl.* p. 80 (1858).

The type-specimen is unset and in very poor condition, and the species is consequently undeterminable by the original description, and I therefore redescribe it.

Long. corp. 4-4½ millim.; exp. tegm. 10-11 millim.

Brown; orbits, some lines on the thorax, and the incisions of the abdomen (narrowly) whitish; legs testaceous. Tegmina light brown, varied with black and subhyaline markings; all the nervures white, and marked with single or double rows of black spots, from each of which proceeds a single hair; at the extremity of each nervure, just before the margin, which is whitish, the extreme outer edge being brown, stands a distinct white spot. The principal subhyaline or whitish markings are firstly two large and one small space on the costa, separated by darker spaces, and followed by a large stigma-like mark, which is light brown, edged with pale at each extremity. The first of these, which sometimes coalesces with the second after crossing the first nervure, runs down in a point half across the wing; below and beyond its lower part stand some black markings, and there is another on the inner margin, surrounded with a clear space. Beyond this is an oblique clear spot rather below the middle of the wing, and a smaller one near the inner margin, separated by a black spot. Beyond the third vitreous spot on the costa a blackish line, forming a slight curve towards the base, runs nearly to the inner margin; it is bordered on the outer concavity with pale. Beyond this is a conspicuous oblique black spot on the inner margin, and two small black spots (sometimes connected into a short, slightly zigzag line) about the middle of the wing. Between the stigmoid spot and the tip of the tegmina is a large dusky space, with a white dot near its upper edge, and its inner side narrowly edged with pale. Beyond it is a white band, more or less divided in two by an oblique spot opposite the hind margin, but not quite extending either to the costa or the inner margin. Wings iridescent subhyaline, with brown nervures.

This species is difficult to describe intelligibly, but should be easily recognizable by the white nervures, bearing setiferous black dots and ending in a submarginal series of white spots.

Pundaloya.

## \*†CIXIUS STIGMA.

*Cixius stigma*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 105 (1863).

*Nura Ellia* and *Patannas* (*Motschulsky*); *Pundaloya* (*Green*).

An unusually large species.

## BRIXIA SUBFASCIATA.

*Brixia subfasciata*, *Stål, Berl. ent. Zeitschr.* iii. p. 320 (1859).

Described from Ceylon.

## \*†BRIXIA TORTRICIFORMIS, sp. n. (Plate V. fig. 12.)

Long. corp.  $4\frac{1}{2}$  lin.; exp. tegm. 12 millim.

Brown above, metanotum and base of abdomen paler; thorax tricarinate, the carinæ on the pronotum and the inner edge of the two contiguous interocular carinæ pale yellowish white; pronotum and mesonotum edged behind with an oblique lateral stripe of the same colour. Under surface yellowish white, the hinder part of the four converging carinæ on the face, a stripe on each side within the two innermost, where they recede to meet the outer ones, a stripe below each eye, and the antennæ above, brown. Tegmina yellowish, subhyaline, clouded with lighter or darker brown; nervures brown or yellow, set with long setæ; costal area subhyaline to beyond the middle, with four oblique light-brown bars; under the inner extremity of the second stands another light-brown blotch, but from its outer extremity a continuous wide curve runs outwards and inwards to the inner margin, where it is darker; it rests on the uppermost of two narrow parallel blackish lines, which occupy the basal half of the inner margin; within it two oblique blackish dashes rise, the outermost is followed by a short curved line beyond it parallel to the curve, the innermost is surmounted by three long brown veins, between the two lowermost of which is a brown dash. On the costa the 4th transverse stripe is followed by a long subhyaline space, the middle of which is interrupted by a brown patch, marked on the outer side below with yellow; beyond this the costa and upper half of the hind margin are edged with brown, but a long and a short black line first descend from this, followed near the apex by a large brown blotch edged with whitish, narrow above and broad below; beyond the tip the brown margin of the wing becomes double, and then angulates inwards, and ceases in a light brown shade covering the wing below the apical blotch. Just above the hinder angle stands the head of a black blotch, which curves to a point on the outer part of the inner margin,

like a comina. Just within this a black streak, bifid below, rises from the inner margin, within which is a pale brown line, surmounted by 3 more brown lines about the middle of the tegmina. Wings fuscous; the neuration is rather peculiar: the subcostal nervure runs very near the costa, and throws off two branches upwards; the two next longitudinal veins are also forked; the subcostal is connected with the next by a straight transverse nervule, and on the other side rises an oblique nervule which extends to the hind margin, crossing the upper fork of the third longitudinal nervule.

A pretty little species, much resembling a *Tortrix*, and very difficult to describe. It appears to belong to Stål's genus *Brixia*; but I cannot make it conform to the description of his Cinghalese *B. subfasciata*; nor does he mention the setose veins in his definition of the genus or species.

Nawalapitya.

#### PTOLERIA ARCUIGERA.

*Ptoleria arcuigera*, Stål, *Berl. ent. Zeitschr.* iii. p. 321 (1859).

Described from Ceylon.

#### Genus BRIXIOIDES, g. n.

Head narrower than the thorax; antennæ inserted below the hinder part of the eyes, and emitting a long seta; no ocelli observed. Thorax tricarinate, front of head projecting beyond the eyes, and viewed from above apparently bifid; but this appearance is really caused by the ends of two very prominent ridges running between the eyes in front, and forming a very long and conspicuous groove. Legs slightly compressed; hind tibiæ bispinose, and widened at the extremity, which is armed with a row of strong spines. Tegmina subopaque, with the apex rounded and the hind margin sloping outwards to the much more prominent hinder angle; costal area with numerous cross nervures, the principal nervures forked, and the outer part of the tegmina with numerous transverse nervures. Wings hyaline, with most of the nervures forked.

A genus of doubtful position, of the general appearance of an *Aphrophora*, but the cross-nervures in the costal area approach it to the *Flatidæ*, and the strongly bicarinated front to *Brixia*.

\*†*BRIXIOIDES CARINATUS*. (Plate V. fig. 9.)

Long. corp. 4 lin.; exp. tegm.  $13\frac{1}{2}$  millim.

Testaceous; head and thorax above with broad black markings on each side of the central carina, and sides of thorax with several longitudinal black dashes; abdomen blackish in the middle and on the sides. Frontal carina and legs nearly white, with numerous transverse black striæ. Under surface of body testaceous, with two black lines on the pleura, the lower one macular; ventral surface of abdomen mostly black in the middle. Tegmina buff, slightly transparent, with 12 or 15 oblique light brown striæ on the costa, intersecting the cross nervures, which are nearly straight, and concolorous with the tegmina. The region of the anal angle is infuscated, and the third and fifth of the striæ from the tip converge and extend nearly to the anal angle; the two outermost striæ are directed obliquely inwards instead of outwards, but the last curves outwards again to the hinder angle, where it is almost divided into black spots; and between it and the extremities of the 3rd and 5th stripes (which are also brown) beyond the costal region are several more black dots. The brown bars towards the base of the tegmina are variable in number, even on opposite sides of the same specimen. On the rest of the tegmina the nervures are sparingly dotted with dark brown; and there are two much larger spots placed obliquely about the middle of the basal third of the tegmina. Wings hyaline, clouded towards the lower part of the hind margin. Pundaloya.

DELPHACIDÆ.

\*†*DELPHAX ERNESTI*, sp. n. (Plate V. fig. 14.)

Long. corp. cum tegm. 4-5 lin.

Testaceous; head, face, and thorax strongly tricarinated: tegmina subhyaline, with a broad brown bar at one-fourth of their length, running from the costa obliquely forwards to the inner margin; this is followed by a row of three black dots, the first considerably below the costa, and the last resting on the inner margin; the outer half of the tegmina is clouded, leaving a semilunular vitreous space on the costa, below which the shade is darkest; round the apex of the wing are eight black dots, two of which stand on the costa, within the clear space, and there is another isolated spot near the inner margin at about half its length. The nervures of the tegmina are set with hairs, and in



the clouded space are black, spotted with testaceous. Wings hyaline.

Appears to be a common species.

Pundaloya.

\*†DELPHAX SIMPLEX, sp. n.

Long. corp. cum tegm. 5 millim.

Testaceous; head, face, and thorax tricarinate; tegmina yellowish subhyaline, with a row of spots all round, except on the basal half of the costa, and 4 or 5 additional spots in the middle of the wing, mostly placed on the longitudinal nervures.

Pundaloya.

DELPHAX MARGINALIS.

Delphax marginalis, *Motsch. Bull. Mosc.* xxxvi. (3) p. 108 (1863).

Described from Ceylon (Nura Ellia and Patannas).

DELPHAX UNISTRIGOSUS.

Delphax unistrigosus, *Mtsch. Bull. Mosc.* xxxvi. (3) p. 108 (1863).

Described from Ceylon (Patannas).

DELPHAX SORDESCENS.

Delphax sordescens, *Motsch. Bull. Mosc.* xxxvi. (3) p. 109 (1863).

Described from Ceylon (Colombo).

DELPHAX VENOSUS.

Delphax venosus, *Motsch. Bull. Mosc.* xxxvi. (3) p. 109 (1863).

Described from Ceylon (Colombo).

DELPHAX ALBICOLLIS.

Delphax albicollis, *Motsch. Bull. Mosc.* xxxvi. (3) p. 110 (1863).

Described from Ceylon (Colombo).

DELPHAX COLORATUS.

Delphax coloratus, *Motsch. Bull. Mosc.* xxxvi. (3) p. 110 (1863).

Described from Ceylon (Colombo).

MESTUS MORIO.

Mestus morio, *Motsch. Bull. Mosc.* xxxvi. (3) p. 111, pl. ii. f. 24 (1863).

Described from Ceylon (Patannas).

MESTUS TESTACEUS.

Mestus testaceus, *Motsch. Bull. Mosc.* xxxvi. (3) p. 112 (1863).

Described from Ceylon (Nura Ellia and Patannas).

*MESTUS* (?) *NIGROPUNCTATUS*.

*Mestus* (?) *nigropunctatus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 112 (1863).

Described from Ceylon (*Patannas*).

*DERBIDÆ*.*DERBE FURCATOVITTATA*.

*Derbe furcatovittata*, *Stål, Vet. Akad. Förhandl.* xii. p. 191 (1855).

Described from Java; included in *Motschulsky's* list as *Cinghalese*.

*DERBE* (?) *NITAGALENSIS*, sp. n. (Plate V. fig. 3.)

Long. corp. 4 lin.; exp. al. 18 millim.

Orange-tawny, with a white line on the median line of the head and thorax; the orbits and sides of the head are mostly white, and there are two white stripes on each side of the thorax above; the outermost, as well as two narrower ones on the pleura, extending more or less over the femora. Tegmina with the subcostal nervure and its branches broad, and orange-tawny beyond the middle, the other nervures paler, mostly whitish, and with the cells and spaces between the nervures filled up with irregularly alternating long stripes of brown and subhyaline, the arrangement of which can be better seen in the figure than described. Wings about half the length of the tegmina, and very similarly marked.

*Hab.* Nitagala.

*DERBE* (?) *CRENATONERVOSA*.

*Derbe* (?) *crenatonervosa*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 113, pl. ii. f. 25 (1863).

Described from Ceylon (*Nura Ellia*).

\*† *THRACIA PTEROPHOROIDES*.

*Derbe* (*Thracia*) *pterophoroides*, *Westw. Ann. Nat. Hist.* (2) vii. p. 210 (1851).

Described from Ceylon; Mr. Green's specimens are from *Nawalapitya*.

\*† *THRACIA CUMULATA*.

*Thracia cumulata*, *Walker, Journ. Linn. Soc. Lond., Zool.* x. p. 139 (1868).

Described from Amboina and Bouru. Mr. Green's specimens from *Nawalapitya* do not appear to be distinct.

## \*†THRACIA CEYLONICA, sp. n.

Exp. tegm. 27 millim.

Testaceous; the tip of the second joint of the antennæ and the carinæ of the abdomen, especially towards the extremity, marked with bright red; a large white waxen spot on each side between the base and the tegulæ; abdomen black beneath. Tegmina brownish hyaline, with brown nervures; the costal, subcostal, and apical nervures bright red; costal area yellowish, a brown space in the middle of the subcostal area within the cross nervure; most of the oblique nervures running from the lowest red nervure thickened and more or less clouded at their origin; a brown spot at the end of the subcostal space, and another at the tip of the tegmina; the two upper nervures branching from the extremity of the subcostal space are red and thickened, and the two lower ones brown, red only at the extremity, tip edged with a narrow red line, inner margin with a brown one; but all four are marked with white before the tip. Wings very small and pointed, not extending much beyond the two anal nervures on the tegmina; brownish hyaline, with the nervures and the tip brown, the former red towards the costa.

Exact locality not noted.

Allied to *T. ephemeralis*, Walk., from New Guinea.

## \*†THRACIA LANKANA, sp. n.

Exp. tegm. 22 millim.

Head and pronotum yellowish above, the former with four brown marks across the middle, the two innermost rounded, and four brown streaks behind; abdomen testaceous, with brown spots on the sides; terminal segment marked with bright red. Under surface testaceous; abdomen with black transverse lines in the middle. Tegmina hyaline, with brown nervures; the nervures towards the costa and apex, including that bounding the apex, and the base of the nervure bounding the inner margin, bright red; front of costa with a white waxen basal streak; costal area yellow, enclosing a row of long brown dashes from one-third of the length of the tegmina to the apex, which is more squarely truncated than in *T. ceylonica*. Wings very short, not extending much beyond the lowest anal nervure on the tegmina; all the nervures bright red.

Allied to *T. ceylonica*, but sufficiently distinct.

Nawalapitya.

\*†*THRACIA* (?) *OBSOLETA*, sp. n. (Plate V. fig. 7.)

Exp. al. 28 millim.

Body brown above; vertex and antennæ tawny yellow; hinder raised ridge of pronotum, a narrow central carina on scutellum, and terminal segment of abdomen white. Under surface white. Tegmina moderately broad, hyaline, the nervures pale testaceous, often shading into white, especially beneath, those towards the costa and inner margin darkest. The hinder angle is rounded off, but is sufficiently distinct to separate the lower part of the hind margin, running from the truncated apex, from the inner margin. A dusky spot covers the base of the tegmina, and there is a blackish spot on the inner margin at  $\frac{3}{5}$  of its length, at the extremity of the first anastomosing nervure. Beyond this, at the next fork, 3 or 4 dusky spots can just be discerned running up towards the middle of the wing, and then three more, directed outwards. Wings hyaline, with white nervures, extending as far as the hinder angle of the tegmina.

Hardly congeneric with the other species, having broader tegmina and much larger wings. The specimens were ticketed "*Phenice*" by the late Mr. Atkinson; but on the whole seem to agree better with *Thracia* in their characters.

Pundaloya.

\*†*PHENICE* *MÆSTA*.

Derbe (*Phenice*) *mæsta*, *Westw. Ann. Nat. Hist.* (2) vii. p. 209 (1851).

Described from India. Appears to be common in Ceylon. Mr. Green's specimens are from Colombo.

Gregarious; frequents the leaves of the sycamore (*E. E. G.*).

*PHENICE PUNCTATIVENTRIS*, sp. n. (Plate V. fig. 6.)

Long. corp. 3 lin.; exp. al. 14 millim.

Yellow, with green lines, more or less distinct and sometimes obsolete, between the eyes, and on the sutures of the head, thorax, pleura, and abdomen. Abdomen with a double row of black spots on each side above. Tegmina brown, with a broad vitreous band on the costa, and another, commencing on the basal third of the inner margin, and then filling up the whole of the middle of the tegmina, to the hind margin, where it is marked with two brown spots; in the central vitreous band there are four or five short brown dashes on the transverse nervules. The vitreous part of the costa is marked on the outer half with small brown marginal dots, and the brown outer part of the

inner margin with small vitreous marginal dots. Wings narrow, half the length of the tegmina, subhyaline, with two conspicuous brown dashes on transverse nervures—one near the base on the inner margin, and the other subcostal, at half the length of the wing.

*Hab.* Nawalapitya (very common).

Allied to *P. mæsta*, Westw.

#### ERANA NIGRICORNIS.

*Erana nigricornis*, Stål, *Æfv. Vet.-Akad. Förh.* xv. p. 449 (1858).

Described from Ceylon.

#### GENESTIA VITRICEPS.

*Genestia vitriceps*, Stål, *Æfv. Vet.-Akad. Förh.* xv. p. 450 (1858).

Described from Ceylon.

#### ISSIDÆ.

##### LUSANDA FISSICEPS.

*Lusanda fissiceps*, Stål, *Berl. ent. Zeitschr.* iii. p. 322 (1859).

Described from Ceylon.

##### CALISCELIS EXIMIA.

*Caliscelis eximia*, Stål, *Berl. ent. Zeitschr.* iii. p. 323 (1859).

Described from Ceylon.

##### \*EURYBRACHYS DILATATA.

*Eurybrachys dilatata*, Walk. *List Hom. Ins. B. M.* ii. p. 392, n. 25 (1851).

Described from Ceylon.

##### \*EURYBRACHYS TOMENTOSA.

*Cicada tomentosa*, Fabr. *Syst. Ent.* p. 683, n. 10 (1775).

Occurs in India and Ceylon.

##### \*†EURYBRACHYS SPINOSA.

*Cicada spinosa*, Fabr. *Ent. Syst. Suppl.* p. 520 (1798); *Coqueb. Illust. Ins.* p. 35, pl. ix. f. 4 (1799).

An Indian species, but the locality given by Fabricius is Mauritius. Coquebert's figure is either much better than the description of Fabricius, or else he figured a different insect, although Fabricius afterwards cited his figure. Mr. Green's specimens are from Putlam.

##### EURYBRACHYS FRATERNA.

*Eurybrachys fraterna*, Stål, *Æfv. Vet.-Akad. Förh.* xv. p. 450 (1858).

Described from Ceylon.

*EURYBRACHYS CRUDELIS.*

*Eurybrachys crudelis*, *Westw. Ann. Nat. Hist.* (2) vii. p. 208 (1857).

Described from Ceylon.

\*†*EURYBRACHYS WESTWOODII*, sp. n. (Plate VI. fig. 1.)

Exp. tegm. 44-55 millim.

Head, pronotum, and scutellum dull green, inclining to yellowish behind, and speckled with brown; front testaceous; legs dilated, green, tibiae more or less speckled with black; hind femora and tarsi black. Abdomen red above, pale green beneath, with broad dark green bands on the front of each segment, and lateral spots beyond; apex densely covered with white waxy efflorescence. Tegmina with the hind margin curved outward; costa one sixth shorter than the inner margin, dull white, reticulated and slightly clouded with brown; basal third green, interspersed with white, and partly following the general outline of the hind margin, and marked in the middle and at its extremity opposite the middle of the hind margin, and on the inner margin, with some irregular black spots; along the costa runs a row of small black dots, interrupted beyond the green part of the tegmina, then recommencing in a single or irregularly double row, becoming larger as they continue to curve round the hind margin; on the inner margin they become a more regular double series, ending in one large spot at about three fourths of the length of the inner margin. Wings white, with the basal third blood-red, the costa beyond tinged with green; three large round black spots towards the extremity of the wing, and some very small black submarginal dots beyond. Underside: tegmina with the green at the base much deeper, without white markings, but more or less spotted and reticulated with black; the rest of the wing is whiter and hardly reticulated with brown, which renders the submarginal spots more distinct.

Resembles *E. pulverosa*, Hope, in the colour of the tegmina, and *E. crudelis*, Westw., in the colour of the wings.

Kandy.

*NICIDUS FUSCONEBULOSUS.*

*Nicidus fusconebulosus*, *Stål, Œfv.-Vet. Akad. Förh.* xv. p. 451 (1858).

Described from Ceylon.

## \*†HEMISPHERIUS SCHAUMI.

Hemisphærius Schaumi, *Stål, K. Vet.-Akad. Förhandl.* xii. p. 191 (1855).

Described from Ceylon.

## \*†HEMISPHERIUS BIPUSTULATUS.

Hemisphærius bipustulatus, *Walk. List Hom. Ins. B. M., Suppl.* p. 95 (1858).

Described from Ceylon. A fresh specimen (not marked with special locality) is green, with the tegmina finely punctured, but not reticulated, and with two slender subparallel red lines on the front.

## \*HEMISPHERIUS DUBIUS.

Hemisphærius dubius, *Butl. Ann. Nat. Hist.* (4) xvi. p. 97, pl. iv. f. 17 (1875).

Described from Ceylon.

## \*†HEMISPHERIUS HERBACEUS, sp. n.

Long. corp.  $5\frac{1}{2}$ , lat. 4 lin.

Green, finely punctured; front with two parallel black lines, widest in the middle, and separated by a yellowish stripe; tegmina green, finely punctured, slightly transparent and reticulated, base of costa with two parallel rufous-brown lines, and a very narrow yellowish edging continued round the rest of the tegmina, except on the inner margin; pectus, pleura, and abdomen with black stripes, those on the abdomen transverse; legs green, lined with black; tarsi testaceous, claws black.

The black stripes on the face distinguish this species from any other known from Ceylon.

Pundaloya.

## \*†PTERILIA CEYLONENSIS.

Pterilia ceylonensis, *Stål, Berl. ent. Zeitschr.* iii. p. 332 (1859).

Not an uncommon species.

## FLATIDÆ.

## Genus MICROCHORIA.

A genus of uncertain position, apparently belonging to the Flatidæ by the majority of its characters, but with a superficial resemblance to *Dichoptera*.

Head large, but slightly narrower than the pronotum, and

about two fifths as long as the total length of the insect, being slightly contracted at rather less than half its length beyond the eyes, and produced into a long, pointed, slightly compressed cone. Antennæ placed below the eyes. Tegmina opaque, with no stigma; costal area with numerous cross nervures; the longitudinal nervures on the disk branched, and with faint traces of cross nervures beyond the middle; tegmina hyaline, with the nervures branched, but with two spaces on the upper part of the wing (not to speak of the inner marginal region) open from the base to the hind margin; below the second is the only cross nervure, at about two thirds of the length of the wing. Head and thorax tricarinate above as far as the constriction; beyond this the terminal cone is compressed, and carinate above; below the head and cone have two strong median carinæ. Legs moderately stout.

\*†MICROCHORIA ABERRANS, sp. n. (Plate V. fig. 10.)

Long. corp. 8 lin., exp. al. 16 millim.

Testaceous, tegmina with numerous black dots on or near the nervures, chiefly near the costa and towards the hind margin, before which is a more or less continuous line of spots; wings hyaline; claws black.

An inconspicuous, but very remarkable species.

Pundaloya.

\*†ELASMOSCELIS PLATYPODA, sp. n. (Plate VI. fig. 3.)

Long. corp. cum tegm. 7 millim.

Black; head yellowish white, front narrow, bifid, with a central black line, and two oblique black lines on each side; face with transverse black bands; front femora and tibiæ very broad and flattened, carinated above and below, and the femora with a lateral carina, above which they are banded with yellowish white; below there are a few small irregular spots, but the tibiæ are regularly spotted with yellowish white both on the upper and lower margins. Middle femora and tarsi much less expanded, banded alternately with black and yellowish white. Tarsi and hind legs yellowish white; tips of femora and some spots on the lower surface of the hind femora and tibiæ brown; hind tibiæ with two spines in the middle, and an expanding carina below. Thorax with a yellowish dash on each side at the back of the pronotum, and a yellowish spot on each side near the extremity of the metanotum. Tegmina dark brown, with a white spot in the middle, and a row of white spots, mostly oblique, and varying in



size, on the costa and hind margin; there are also a few other small white spots and dots on the inner margin and disk. Wings brown.

Probably allied to *E. tagalica*, Stål, from the Philippines.

Exact locality not recorded.

\*†*ELASMOCELIS* (?) *RADIANS*, sp. n. (Plate VI. fig. 2.)

Long. corp. 4 millim., cum tegm. 6 millim.; exp. tegm. 12 millim.

Body above dark brown; thorax tricarinate; head white in front beyond the middle of the eyes; vertex as broad as the width of the eyes, bifid in front; head, pectus, and legs white, legs not expanded; femora broadly black in the middle, tibiae narrowly ringed with black; ventral surface of abdomen blackish. Tegmina dark brown; costa and hind margin white, broken into spots by the ground-colour radiating into it, most broadly on the hind margin; there are also numerous narrow undulating dashes running from the inner margin, especially towards the base. The outer half of the dark part of the tegmina inclines to red towards the costa, and is marked with three large black spots, imperfectly differentiated from the ground-colour; between these and the inner margin are some smaller ill-defined dark dots and dashes. Wings brown.

Differs from typical *Elasmoscelis* in the broader vertex and non-appendiculate legs; but I prefer to leave it provisionally in that genus, to which it appears nearly allied.

Pundaloya.

Found on *Bambusa*. Larva with two long spiral caudal appendages formed of a white waxy secretion (*E. E. G.*).

*TAMBINIA LANGUIDA*.

*Tambinia languida*, Stål, *Berl. ent. Zeitschr.* iii. p. 317 (1859).

Described from Ceylon.

*TAMBINIA DEBILIS*.

*Tambinia debilis*, Stål, *Berl. ent. Zeitschr.* iii. p. 317 (1859).

Described from Ceylon.

*TAMBINIA RUFO-ORNATA*.

*Tambinia rufo-ornata*, Stål, *Berl. ent. Zeitschr.* iii. p. 317 (1859).

Described from Ceylon.

\*†*PHALÆNOMORPHA EROSIPENNIS*.

*Phalænomorpha erosipennis*, *Stål, Œfv. Vet.-Akad. Förh.* xv. p. 451 (1858).

There is a whitish insect, varied with green, in Mr. Green's collection from Kandy; and a greenish insect, with a curved dark line running from the base to the tip, in the Museum collection; and I refer these, with some doubt, to this species. The latter was ticketed "*Elidiptera perplexa*" by Walker, but does not seem to have been described. Stål's descriptions are often very poor, and quite insufficient to identify his species, which may account, in part, for the virulence of his attacks on Walker, whose work he persistently ignored, instead of forwarding science by endeavouring to elucidate it.

*PHALÆNOMORPHA NIETNERI*.

*Phalænomorpha Nietneri*, *Stål, Œfv. Vet.-Akad. Förh.* xv. p. 452 (1858).

Described from Ceylon.

\*†*PHALÆNOMORPHA EMERSONIANA*.

*Elidiptera Emersoniana*, *Walk. List Hom. Ins. B. M., Suppl.* p. 73 (1858).

*Pœcilopecta Tennentina*, *Tennent, Nat. Hist. Ceylon*, p. 433, fig. (1861).

Described from Ceylon. Appears to be a variable species.

Found on lichen-covered trunks of trees (*E. E. G.*).

Pundaloya and Nawalapitya.

\*†*PHALÆNOMORPHA INCONSPICUA*, sp. n.

Long. corp. 6 millim.; exp. tegm. 16 millim.

Greenish, slightly varied with rufous above; prothorax more distinctly green, abdomen more inclining to yellowish, head beneath and legs rufo-testaceous. Head extending for more than half its length beyond the eyes, angulated on each side and then rounded in front; face with a central carina; hind tibiæ with two spurs; tegmina about four times as long as broad, pale brown, with brown or green nervures, the latter chiefly towards the base or in the interior of the outer half of the tegmina; costal and apical areas very broad, the cross nervures placed close together and but slightly oblique. Wings pearly white, with testaceous nervures, those towards the base and the second from the inner margin green.

Allied to *P. Emersoniana*, but much smaller, and with the costal and apical areas much wider.

Pundaloya.

\*†*PHALÆNOMORPHA PARVA*, sp. n.

Long. corp. 5 millim. ; exp. tegm. 14 millim.

Testaceous ; abdomen broad below, with white transverse stripes ; head and thorax slightly mottled with black ; head and mesothorax dull yellow. Head extending for about half its length beyond the eyes, truncated, hardly produced beyond the lateral angles ; tegmina about three times as long as broad ; costal and apical areas very broad, with nearly straight cross-nervures, but distinctly narrower towards the tip ; all the nervures testaceous spotted with brown. Wings dirty white, with testaceous nervures.

Allied to the last species.

Pundaloya.

*PHALÆNOMORPHA* (?) *ABDOMINALIS*, sp. n. (Plate V. fig. 16.)

Long. corp. 7 lin. ; exp. tegm. 17 millim.

Head and pronotum brown ; mesonotum reddish brown, darkest in the middle ; head, pectus, and legs more yellowish ; abdomen greenish above, shading into yellow on the sides and beneath, laterally compressed, and much raised in the middle. Tegmina brown ; costa arched ; a strong rounded projection on the inner margin towards the base, but beyond the middle both the costa and inner margin form a long shallow concave curve, rendering this part of the tegmina narrowest ; the costal region is more or less pale, with numerous cross-nervures ; at two thirds of its length the pale space, which is there greenish above, extends downwards for a third of the width of the tegmina, and is bounded outside by an oblique brown shade running from just within the apex. Several of the nervures on the upper part of the central area of the tegmina are infuscated before the middle. The apex and hinder angle are distinct, but rounded off ; the marginal area is not very well defined, but is broadest at the hinder angle. Wings fusco-hyaline.

Not closely allied to any described species.

Exact locality not specified.

*CHRONEBA PALLIFRONS*.

*Chroneba pallifrons*, Stål, *Berl. ent. Zeitschr.* iii. p. 320 (1859).

Described from Ceylon.

\*†SELIZA BISECTA, sp. n. (Plate V. fig. 5.)

Long. corp. cum tegm. 8 millim.

Castaneous above, testaceous below; head and thorax broadly black in the middle above; tegmina dark brown; costa slightly arched, and the subcostal nervure more so, rendering the costal area rather narrow, but the apical area is very broad, and the space between the nervures lighter than the central area; internal area bounded by a very distinct testaceous streak along the fold; wings dark fuscous.

Not closely allied to any described species; except in the shape of the head, in which it agrees with *Ricania*, it much resembles a *Phalænomorpha*.

Putlam.

\*†SELIZA NIGROPUNCTATA, sp. n.

Long. corp. cum tegm. 7 millim.; lat. max. tegm.  $3\frac{1}{2}$  millim.

Head and pronotum chocolate-brown above; face rather lighter, with testaceous lateral and central carinæ; under surface of body testaceous; tegmina brown with black veins, blackening towards the rounded projection on the base of the inner margin and towards the hinder angle of the central area; the inner marginal area towards the base, and the basal third of the central area, with numerous large raised black granules; the costal and marginal areas very broad, but broadest at the apex; cross-nervures nearly straight.

Much resembles *Pæcileptera punctifrons*, Walker (which is referred to *Seliza* by Walker in a MS. note); but the nervures are darker, and the costal and submarginal areas broader.

\*†RICANIA FENESTRATA.

*Cercopis fenestrata*, *Fabr. Syst. Ent.* p. 688, n. 1 (1775).

*Cicada hyalina*, *Fabr. l. c.*, App. p. 832 (1775).

Appears to be very common in Ceylon. Mr. Green's specimens are from Pundaloya.

\*†RICANIA TENEBROSUS.

*Ricania tenebrosus*, *Walk. List Hom. Ins. B. M.* ii. p. 406, n. 7 (1851).

Common in the East Indies; probably a variety of *R. speculum*, Walk. Mr. Green's specimens are from Putlam.

\*†RICANIA ANGULATUS, sp. n.

Exp. al. 24 millim.

Brown; head wanting; thorax and pectus black; legs tes-

taceous. Wings brown, subhyaline; tegmina darkest on the costa, with a hyaline mark in the middle, larger and more obtuse at the extremity than in *R. striatus*; obliquely from the apex a hyaline band runs down to the fold; it commences rather narrowly, and widens; at rather more than half its length it is angulated obtusely inwards, and then rectangularly downwards, both angles being fairly well marked, especially the second. Wings with a similar vitreous band running from the costa, where it is broadest, three fourths across the wing towards the anal angle.

Differs from *R. fasciata*, Amyot, in the shape of the band.

Pundaloya.

\*†*RICANIA STRIATUS*, sp. n.

Exp. al. 30 millim.

Dark reddish brown; pronotum and costa of tegmina more or less distinctly blackish; legs testaceous. Tegmina with a hyaline spot on the middle of the costa, forming a long triangle, the basal side twice as long as the marginal. Two blackish lines beyond the middle of the wing, the outer one bordered first outside, and then crossed and bordered inside by a narrow reddish line; half-way between this and the hind margin is another more regular narrow reddish line.

Allied to *R. obscura*, Fabr.

Aniswella, July 1888; and Putlam.

An allied species from Ceylon has been identified by Walker (doubtfully, and almost certainly erroneously) with *Pæciloptera pulverulenta*, Guérin, described from Campeachy Bay. I do not care to describe Walker's Cinghalese insect from a single specimen, not in the best condition.

\**SCARPANTA TENNENTINA*.

*Pæciloptera Tennentina*, *Walk. List Hom. Ins. B. M., Suppl.* p. 111 (1858).

Elidiptera Emersoniona, *Tennent, N. H. Ceylon*, p. 433 (1861).

Described from Ceylon.

\*†*SCARPANTA LATIPENNIS*, sp. n. (Plate VI. fig. 9.)

Exp. tegm. 25 millim.

Body and tegmina yellow (faded leaf-colour). Tegmina very broad, the costa strongly arched, and the angles rounded off; the inner margin likewise curved strongly outwards near the base making the outline that of an obtuse-angled triangle, with the

angle itself rounded off; at nearly three fourths of the distance from this bend to the hinder angle is a black spot on the inner margin; and at about three fourths of the length of the hind margin is a black spot, from which a series of small disconnected irregular black markings run up towards the middle of the wing; there are also some very small scattered black specks and obsolete dusky mottlings on other parts of the tegmina. Tegmina beneath pale yellowish green, irregularly irrorated with white; all the black spots and specks are covered with white, especially those running from the hind margin, which are rather broader than above; from the inner side of the last dark spot a series of whitish markings runs towards the tip; a series of smaller ones runs from the spots on the inner margin through the transverse dark spots, also towards the tip, and there are several other whitish mottlings on other parts of the tegmina; these are not well-defined clear white spots, but more or less subobsolete and suffused in appearance. Wings white, subhyaline, the nervures concolorous.

Closely allied to *S. Tennentina*.

One specimen from Kandy.

\*†PÆCILOPTERA GLAUCA, sp. n. (Plate VI. fig. 14.)

Exp. al. 27-31 millim.

Tegmina pale bluish grey, hind marginal area paler; hind wings more grey, iridescent. Body white, scutellum and legs black; abdomen covered with white feathery waxy excrescences.

Allied to *P. tineoides*, Oliv., but more uniform in colour and with broader wings. It is not unlike *Scarpauta Tennentina* in shape.

Gregarious. Frequents various species of *Eugenia* (E. E. G.). Pundaloya.

\*†PÆCILOPTERA QUADRATA, sp. n. (Plate VI. fig. 8.)

Exp. tegm. 16-21 millim.

Grass-green; tarsi ferruginous. Tegmina with the costa slightly arched, and the tip and hinder angle nearly rectangular, the former slightly rounded off; inner margin oblique for the basal fourth, then suddenly curved outwards at more than a rectangle, and thence running at a very slight curve to the hinder angle. The costa, hind margin, and outer fourth of the inner margin, as well as the basal angle of the last, narrowly edged with orange; beneath the orange line the costa is more broadly

bordered with yellow. Nervures green, subcostal nervure running parallel to the costa for some distance, and then curving round parallel to the hind margin, but leaving a broader space between the line and the hind margin than between the line and the costa; but before reaching the inner margin it curves suddenly inwards, and ceases just above the point where the orange line ceases on the inner margin. The last nervure from the base near the inner margin is more distinctly green than the others, and its neighbourhood is granulated with green. Wings pearly white, nervures slightly greenish. On the under surface of the tegmina is a transverse curve, hardly visible above, branching from the costal nervure before the upper curve, and then running downwards and obliquely inwards towards the same point on the inner margin.

Allied to *P. truncata*, Linn., but the costal area is much broader, besides other differences.

Putlam.

\*†*PHRONIMA MARGINELLA*.

Fulgora marginella, *Oliv. Enc. Méth.* vi. pp. 566, 575, n. 43 (1791).

Recorded from India, Cambodia, and Ceylon.

\*†*PHRONIMA DELTOTENSIS*, sp. n.

Long. corp. 10 lin.; exp. tegm. 50 millim.

Head and body testaceous, yellower beneath; the summit of the eyes, the antennæ except the base of the scape, which is reddish brown, the four hind tibiæ except more or less of the base above, and the tarsi except the claws, deep black. Tegmina testaceous, the costal edge with a narrow yellow line. Wings opaque white, with testaceous nervures.

Larva reddish brown, with the antennæ and legs darker, and covered with white waxy appendages.

Allied to *P. inornata*, Walk., from Tenasserim, Siam, and Burmah, but with darker legs and antennæ.

Deltota.

\*†*FLATA STELLARIS*.

Pœcilopectera stellaris, *Walk. List Hom. Ins. B. M.* ii. p. 454, n. 39 (1851).

*Cicada ocellata*, *auct. nec De Geer, Fabr.*

Common in Ceylon. The specimens differ slightly in the spotting, but this is known to be a variable character.

Mr. Green's specimens are from Pundaloya.

By an extraordinary error, this species has been identified by most authors with *Cicada ocellata*, Fabricius (afterwards erroneously referred by him to *Flata*), which is identical with that of De Geer, whose figure, which Fabricius quotes, probably represents a species of *Platypleura* allied to *P. Kämpferi*, Fabr. Although there might be some doubt whether the description of Fabricius really applies to De Geer's insect, yet Fabricius would hardly have applied the term "major" to *P. stellaris* when he included his *ocellata* in the genus *Cicada*.

\*†PHYLLYPHANTA ALBOPUNCTATA, sp. n. (Plate VI. fig. 5.)

Exp. tegm. 30 millim.

Green, tarsi ferruginous. Tegmina slightly shaded with white beyond the middle, and with the centres of many of the cells pale; four conspicuous rows of whiter spots; of these, two are longitudinal, starting close together near the base, about the centre of the wing, and then diverging as the tegmina broaden, so as to maintain nearly uniform distances from the costa and inner margin respectively, these extend to rather beyond the middle of the tegmina; the other two rows of whitish spots are transverse, rising towards the tip of the costa, the innermost running obliquely inwards and downwards for two thirds of the width of the tegmina, and the other running nearly straight downwards for a rather longer distance opposite the hind margin. Under surface much whiter, with the rows of spots smaller, more distinct, and further extended. Tegmina with the costa edged with yellow, and the hind margin (more narrowly) with tawny; costa gradually arched, tip acute, rather more than rectangular; hind margin very slightly convex and concave to the very acute and much projecting hinder angle; inner margin with a strong rounded projection near the base, and then gradually curved outwards to the hinder angle; wings pearly white, with a strong projection on the costa near the base, rather more pointed than that on the inner margin of the tegmina.

Not closely allied to any species in the Museum.

\*†PHYLLYPHANTA ACUTIPENNIS, sp. n. (Plate VI. fig. 6.)

*Flata acutipennis*, *Atkinson*, *MS.*

Exp. tegm. 23-30 millim.

Head, body, and tegmina green above; head and pronotum with a broad rusty longitudinal band, blackish on the median



carina itself; face and under surface whitish or pale green; tarsi ferruginous. Tegmina green, veins green (sometimes yellowish towards the base of the inner margin), the centre of the cells often whitish; costa gradually arched, apex nearly rectangular; inner margin obtusely angulated at about five sixths of its length, then gradually curved outwards and downwards to the hinder angle, which is long and very acute; hind margin nearly straight. A rusty yellow line runs round the wing from the base of the costa to the angle near the base of the inner margin; on the basal half of the costa it is bordered below with pale yellow, and from thence nearly to the hinder angle it is dotted within with brown. On the inner margin the yellow border is edged outside, from the basal angle to two-thirds of the distance to the hinder angle, with a dark brown line, above which stand white dots; this is followed by a conspicuous black spot, running up a little into the wing, and beyond by a row of brown dots extending nearly to the hinder angle. Wings satiny white, subhyaline. Tegmina more or less whitish beneath.

A very common species in Ceylon; one of Mr. Green's specimens had been ticketed with the name "*Flata acutipennis*" by Mr. Atkinson, which I have adopted. I cannot find that it has been published.

Allied to *P. productus*, Spin.

Pundaloya.

\*† PHYLLOPHANTA DUBIA, sp. n.

Exp. tegm. 25 millim.

Very like *P. acutipennis*. Front of head rather more pointed; head and pronotum with a black longitudinal carina, bordered with tawny yellow; sides of pronotum with some tawny streaks; tegmina grass-green, with tawny nervures, the cells not centred with white above, beneath paler, but hardly whitish, and the centre of the cells distinctly paler; tegmina with a pale yellow edge, from the base of the costa to the basal angle on the inner margin; dotted with black from beyond the middle of the costa to the hinder angle, and round as far as the large blotch on the inner margin; beyond this and the basal angle is a black line broken at regular intervals. Otherwise as in *P. acutipennis*.

Possibly a variety of *P. acutipennis*.

Putlam.

## \*†MINDURA HEMEROBII.

*Ricania Hemerobii*, *Walk. List Hom. Ins. B. M.* ii. p. 425 (1851).

Described from Ceylon. Mr. Green's specimens are from Pundaloya and Nawalapitya.

## \*†NOGODINA GREENI, sp. n. (Plate V. fig. 15.)

Long. corp. 9 millim.; exp. tegm. 28 millim.

Head and thorax mostly testaceous above, the latter with two black carinæ, diverging behind, the space between these and the central testaceous stripe brown; a black spot on each side in front; abdomen yellow at the sides (greenish at the base) and brown in the middle; marginal carinæ and last two segments black; a white spot at the base of the terminal segment. Face testaceous, with the frontal and lateral carinæ very narrowly black; three testaceous carinæ, diverging and disappearing at a level with the lower boundary of the eyes, which are black in the middle, bordered with yellowish; rostrum black at the base and extremity. Under surface of body pale greenish; coxæ spotted and hind femora lined beneath with black; tarsi and spines of hind tibiæ blackish; abdomen brownish in the middle, and with the sides of the terminal segments black. Tegmina and wings hyaline, with brown nervures; hind margins bordered with smoky brown; tegmina with a large oblong stigma, enclosing a square vitreous spot on the subcostal space; there is also a brown spot at the tip, and another within it; another, confluent with the brown border, stands rather below the middle of the hind margin; and the inner margin is broadly brown, from the point where it forms a rounded projection near the base to the hinder angle; the nervures nearest the inner margin are broad and brown, and the cross-nervures rising before the hinder angle are also slightly clouded.

Somewhat resembles *Mindura Hemerobii*, Walk.

Deltota.

## CERCOPIDÆ.

## PENTHIMIA RUFOPUNCTATA.

*Penthimia rufopunctata*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 94 (1863).

Described from Ceylon (Nura Ellia and Patannas).

## \*†PENTHIMIA MELANOCEPHALA.

*Penthimia melanocephala*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 95 (1863).

Nura Ellia (*Motschulsky*); Pundaloya (*Green*).

## \*†CALLITETTIX AFFINIS.

*Callitettix affinis*, *Atk. Journ. As. Soc. Bengal*, lvii. (2) p. 335 (1889).

Very common in Ceylon.

The apical third of the tegmina, within the black edging, is fuscous, reticulated with red of nearly the same shade as the rest of the tegmina. This point is omitted in the original description of the species.

## \*†CALLITETTIX CAPITATA.

*Callitettix capitata*, *Stål, Œfvers. K. Vet.-Akad. Förh.* xxii. p. 15, n. 3 (1865).

*Phymatostetha insignis*, *Dist. Trans. Ent. Soc. Lond.* 1878, p. 322.

A very common and variable species in Ceylon; the colour of the pronotum varies from red to black; the red at the base of the tegmina is generally more or less lined with black, and sometimes almost obliterated; and the outer part of the tegmina varies from black to subhyaline fuscous.

Mr. Green's specimens are from Pundaloya and Putlam.

## \*†PHYMATOSTETHA INCONSPICUA.

*Phymatostetha inconspicua*, *Butl. Cist. Ent.* i. p. 267 (1874).

Common in Ceylon.

## \*†CERCOPIS INCLUSA.

*Cercopis inclusa*, *Walk. Cat. Hom. Ins. B. M.* iii. p. 658, n. 29 (1851); *Stål, Œfv. Vet.-Akad. Förh.* xxii. p. 147 (1861).

Common in Ceylon. Mr. Green's specimens are from Kandy.

## \*†COSMOCASTA TAPROBANENSIS.

*Cosmocasta taprobanensis*, *Atk. J. A. S. B.* lvii. p. 333 (1889).

A very common insect in Ceylon.

Frequents *Strobilanthus* (*E. E. G.*).

## \*†COSMOCASTA GREENI.

*Cosmocasta Greeni*, *Atk. J. A. S. B.* lvii. p. 334 (1889).

Described from Ceylon.

## Genus RHINASTRIA, g. n.

Vertex much depressed in front, filled up in the middle behind by a broad ridge, on the sides of which the ocelli are placed, which are about equally distant from each other and from the eyes; front produced downwards into a compressed carinated beak,

obtusely pointed below, not unlike that of a puffin in shape; antennæ placed between the base of the beak and the eyes; pronotum nearly smooth, slightly depressed laterally in front, angles not very prominent; scutellum rather large. Tegmina with the costa carinated, convex beyond the middle, a deep groove marked by a black nervure running from near the costa towards the hinder angle; apical third of tegmina reticulated; legs rather long and stout; front femora slightly longer than the others.

Allied to *Cosmocarta*.

\*†*RHINASTRIA BICOLOR*, sp. n. (Plate VI. fig. 12.)

Long. corp. cum tegm. 10 millim.

Tawny; eyes, antennæ, the nervure mentioned in the description of the genus, and the hinder costal and apical margin of the tegmina, as well as the spaces between the nervures on the terminal third, the knees, tarsi, and some spots on the sides of the ventral segments of the abdomen, black.

Aniswella, July 1888.

\*†*PHILENUS HIRSUTUS*, sp. n.

Long. corp. 8-9 millim.

Brownish testaceous, front transversely striated, separated by a broad undivided medial space; two black spots, slightly showing above, just below the middle of the convex and somewhat flattened rim of the head; antennæ, tips of hind tibiæ, and tarsal claws black. Tegmina pointed, with a pale oblique fascia on the costa before the tip, a black spot at the tip, and another, in a pale ring, on the inner margin, at the extremity of the principal nervure; in one specimen, a great part of the outer two thirds of the tegmina is blackish on the costa, as far as the oblique band; it is intersected at about two thirds of the length of the costa by a square pale patch on the costa, nearly connected with the point of a pale subtriangular mark in the middle of the tegmina; the hinder portion of this dark space is concave towards the middle of the tegmina, and runs narrowly towards the inner margin on the basal side of the pale space. The whole insect is so thickly covered with short pale bristles as to entirely conceal the sculpture.

Extremely similar to *Aphrophora alni* in external appearance.

Putlam.

*APHROPHORA LINEATOCOLLIS.*

*Aphrophora lineatocollis*, *Motsch. Études Ent.* viii. p. 110 (1859).

Described from the mountains of Ceylon.

\*†*APHROPHORA FACIALIS*, sp. n.

Long. corp. cum tegm. 7–8 millim.

Testaceous, but covered with large, deep, round, brown pits, which give the whole insect a brown appearance; head brown, with the central carina and a spot on each side behind pale, and some pale smooth spaces surrounded with brown in front of the prothorax, borders of scutellum also pale; an indistinct pale spot, bordered with darker, sometimes visible in the middle of the costa of the tegmina; front with deep brown punctures in transverse rows, giving it the appearance of being transversely striated; it is more or less varied with black, sometimes entirely blackish, except at the lower extremity, but more often with two large blackish lateral spots (sometimes united) about the middle, and smaller ones below. Legs brown, indistinctly banded with paler.

Not unlike our common *Philaenus spumarius*, L.

Pundaloya.

\**PTYELUS COSTALIS.*

*Ptyelus costalis*, *Walk. List Hom. Ins. B. M.* iii. p. 707, n. 13 (1851).

*Ptyelus concolor*, *Walk. l. c.* p. 715, n. 26 (1851).

Recorded from India and Ceylon.

\*†*CLOVIA PERDUCTALIS*, sp. n. (Plate V. fig. 2.)

Long. corp. cum tegm. 9–11 millim.

Warm reddish brown above, thickly punctured; head broad, obtusely pointed, the rim of the head and the base of the inner margin and tip of the tegmina sometimes blackish; tegmina in the middle sometimes varied with yellowish; head carinated above: a conspicuous yellowish stripe, pointed at both ends, but with nearly parallel sides for much of its length, commences a little behind the front of the head and ceases at the tip of the scutellum; it entirely covers the scutellum, except a triangular space on each side at the base. Under surface more or less yellowish.

Pundaloya.

\*†*CLOVIA HUMERALIS*, sp. n.

Long. corp. cum tegm. 8 lin.

Head, pronotum, and scutellum dull testaceous; head and pronotum with two dull reddish stripes, rather wider behind, on each side of the median line; a shorter one, darker behind, within and behind each eye. Head with the front reddish, below which is a blackish half-circle; otherwise testaceous beneath, as are also the sides of the thorax and abdomen and the legs beyond the middle of the femora; otherwise the under surface of the body is blackish. Tegmina pointed in the middle, so that there is no proper hind margin, chestnut-brown, with a testaceous stripe on the basal third of the costa, broadest at the extremity; a slender, transverse, submarginal stripe at the extremity of the costa, preceded by another broad transverse stripe running from the costa just below the tip, and ceasing in a point before reaching the inner margin; on the outer half of the inner margin there are some smaller and more irregular testaceous spots and streaks, which run up to the middle of the tegmina on the basal side.

Allied to *C. exclamans*, Walker, from Sarawak, but with longer and more pointed tegmina.

Pundaloya.

\*†*CLOVIA PERSTRIGATA*, sp. n.

Long. corp. cum tegm. 10 millim.

Upperside dark chestnut-brown, with five slender testaceous stripes between the eyes, and an outer one on each side, interrupted by the eyes, passing backwards and inwards over the vertex, pronotum, scutellum, and adjacent part of the tegmina. Tegmina with a large testaceous spot on the costa about two fifths of the distance between the base and the tip; a testaceous submarginal stripe at the extremity, running from about three fourths of the length of the costa before the tip, preceded by a wide testaceous band, at first running obliquely backwards and inwards, and then suddenly angulated backwards towards the tip, where it ceases in a point; between its starting-point and the costa are three short testaceous lines. Under surface chocolate; the borders of the head and thorax black, edged with testaceous within; legs testaceous, the hind tibiæ striped with black, and the tips of the hind tibiæ and tarsi black.

Allied to the last species.

Pundaloya.

\*†CLOVIA BIPUNCTATUS, sp. n.

Long. corp. cum tegm. 8 lin.

Testaceous, with about six reddish lines, the outer ones interrupted by the eyes, passing backwards to the scutellum and tegmina; tegmina with a reddish-brown stripe, broadest behind, running from the base to beyond the middle, and with two slender lines above it; the tip is edged on each side with the same colour, and preceded by a curved stripe from the costa which ceases before quite reaching the tip; at about three fifths of the length of the costa another stripe runs inward and backward, and then turns at an angle to the inner margin; on the inner margin, rather beyond the point on the costa from whence the curved line runs towards the tip, is a well-marked oval black spot. Underside more rufo-testaceous, with a broad testaceous stripe which runs beneath the head and eyes, bordering the head and thorax.

Allied to *C. perstrigata*.

Pundaloya.

MACHÆROTA GUTTIGERA.

Machærota guttigera, *Westw. Trans. Ent. Soc. Lond.* 1886, p. 332, pl. viii.

Described from Ceylon.

#### MEMBRACIDÆ.

OXYRHACHIS INERMIS.

Oxyrhachis inermis, *Stål, Öfv. Vet.-Akad. Förh.* xxvi. p. 283 (1869).

Described from Ceylon.

\*OXYRHACHIS INDICANS.

Oxyrhachis indicans, *Walk. List Hom. Ins. B. M., Suppl.* p. 128 (1858).

Described from Ceylon.

LEPTOBOLUS CURVISPINUS.

Leptobolus curvispinus, *Stål, Öfv. Vet.-Akad. Förh.* xxvi. p. 284 (1869).

Described from Ceylon.

LEPTOBOLUS AURICULATUS.

Leptobolus auriculatus, *Stål, Öfv. Vet.-Akad. Förh.* xxvi. p. 285 (1869).

Described from Ceylon.

## CENTROTUS REPONENS.

*Centrotus reponens*, *Walk. List Hom. Ins. B. M.* ii. p. 604, n. 14 (1851).

Described from Tenasserim, but included in Walker's list as Cinghalese. It seems to differ from *C. taurus*, Fabr., chiefly in the thicker and more recurved lateral thoracic horns.

It is curious that hardly any of the described *Centroti* included in Walker's list of Cinghalese species were obtained by Mr. Green. Several others mentioned by Walker are MS. only, never having been described.

## \*CENTROTUS (♀) MALLEUS.

*Centrotus malleus*, *Walk. List Hom. Ins. B. M.* ii. p. 613, n. 41 (1851).

A very distinct and remarkable species, which should certainly form a new genus, and appears to be allied to *Machærota*.

Described from Ceylon.

## CENTROTUS SUBSTITUTUS.

*Centrotus substitutus*, *Walk. List Hom. Ins. B. M.* ii. p. 605, n. 16 (1851).

Described from Bengal, but included in Walker's list as Cinghalese.

## CENTROTUS TERMINALIS.

*Centrotus terminalis*, *Walk. List Hom. Ins. B. M.* ii. p. 604, n. 13 (1851).

Described from China; included in Walker's list as Cinghalese.

## \*†CENTROTUS LEUCASPIS.

*Centrotus leucaspis*, *Walk. List Hom. Ins. B. M., Suppl.* p. 158 (1858).

The commonest species in Ceylon.

## \*†CENTROTUS ATRICOXIS, sp. n.

Long. corp. cum tegm.  $7\frac{1}{2}$  millim.; exp. corn. 5 millim.

Black, rugose-punctate, sparingly clothed with short golden hairs; scutellum concolorous. Thoracic lateral horns moderately thick, arching, and slightly recurved; central horn curved backwards and downwards, as long as the abdomen; short lateral angles in front of the base of the tegmina very acute. Legs



castaneous, coxæ black, tips of tibiæ and tarsi inclining to blackish. Tegmina dark chestnut, broadly black at the base and for two thirds of the length of the costa, and the nervures mostly black, except towards the extremities.

Allied to *C. substitutus*, Walker.

Nawalapitya.

Another specimen, which I can hardly consider distinct, has shorter and thicker horns, and the tomentum is white rather than golden. It is covered beneath with a white waxy exudation, as is frequently the case in these insects. The horn is also more depressed.

\**CENTROTUS DECIPIENS*, sp. n.

Long. corp. cum tegm. 6 millim. ; exp. corn. 3 millim.

Black, punctuation rather finer than in *C. flavipes*; lateral thoracic horns acute, slightly recurved, moderately long and slender; central horn raised at the base and then curved backwards, as in *C. leucaspis*, Walk., nearly to the end of the tegmina, which are yellowish hyaline; pectus in the specimen described with waxy efflorescence, which is continued round the sides of the pronotum and the base of the scutellum; tegmina yellowish hyaline, the nervures nearly concolorous, base black, and the costa to the tip rather broadly black; coxæ black; legs rufo-testaceous; hind legs pale testaceous.

Nearest to *C. leucaspis*, from which it differs, *inter alia*, in the colour of the legs and in the white border of the pronotum &c. This is one of Walker's MS. species, which he has ticketed, and which I think it well to take the present opportunity of putting on permanent record.

Ceylon; particular locality not recorded.

\*†*CENTROTUS FLAVIPES*, sp. n.

Long. corp. cum tegm. 7 millim. ; exp. corn. 4 millim.

Closely allied to *C. atricoxis*, of which it may be a variety. The structure is nearly the same, but the tomentum is white, not golden; the legs are testaceous, shading into reddish brown on the tips of the tibiæ and the tarsi, and the tegmina are lighter, the nervures, except those on the black portion, being castaneous. The pectus and pleura are covered with a white waxy exudation.

Nawalapitya.

*CENTROTUS RECTANGULATUS*, sp. n.

Long. corp. cum tegm. circa 5 millim. ; exp. corn. 3 millim.

Dark brown or blackish ; knees, tibiæ, and tarsi rufo-testaceous ; pronotum narrowly bordered with white at the sides ; lateral thoracic horns broad, directed obliquely outwards and upwards, but only slightly backwards, the extremity shortly and broadly trifid, the middle projection longest and most acute ; central spine broad at the base and rising obliquely upwards, and then turned backwards and downwards at a rectangle ; the hinder part is slender, acute, longer than the body, and sometimes inclines to testaceous in the middle. Scutellum armed with two short spines. Tegmina hyaline, the nervures towards the base whitish, and those towards the extremity broadly brown ; a large brown spot at the tip and another at the hinder angle.

Allied to *C. pilosus*, Walker, but darker, and with differently marked tegmina.

A common species in Ceylon.

Pundaloya.

Perhaps allied to Stål's genus *Leptobolus*.

\*†*CENTROTUS GRANULATUS*, sp. n.

Long. corp. cum tegm. 10 millim. ; exp. corn.  $6\frac{1}{2}$  millim.

Entirely dull black, with fine yellowish pubescence ; a testaceous spot on each side of the base of the scutellum and another on the inner margin of the tegmina at three fifths of its length. Thoracic lateral horns broad and flattened, projecting obliquely forward and upward beyond the level of the head, suddenly and squarely truncated at the extremity, bicarinate both above and below, besides the lateral carinæ ; central spine rather broad at the base, nearly straight, and depressed to the level of the tegmina, extending for one fourth of its length beyond the pale spot on the tegmina ; a well-marked dorsal and two lateral carinæ, the latter coalescing at half their length ; pronotum with numerous conspicuous raised black points.

This species and the next have no near allies, but have a distant resemblance to the Australian *C. decisus*, Walker.

Pundaloya.

\*†*CENTROTUS BIOCULATUS*, sp. n.

Long. corp. cum tegm.  $7-8\frac{1}{2}$  millim. ; exp. corn. 5-6 millim.

Deep black ; structure nearly the same as in *C. granulatus*, but

the thorax is thickly and coarsely but uniformly granulated, without isolated raised points; the lateral horns are more upright, not passing beyond the head, and the central spine has only one lateral carina on each side. There are two conspicuous white spots in front of the pronotum before the horns, and two more at the base of the scutellum. Tegmina black, the nervures rufo-testaceous at the extremity, and the inner margin broadly hyaline, except at the base and tip.

Allied to *C. granulatus*.

Pundaloya.

\*†CENTROTUS BUBALUS, sp. n.

Long. corp. cum tegm. 6 millim.; exp. corn. 4 millim.

Deep black; horns long and slender, rising upwards and outwards, and then bent more downward and backward at the tips; central spine rising obliquely upwards nearly to the level of the lateral horn, and then curved over nearly at a right angle and extending almost to the end of the tegmina, the extremity showing a slight upward tendency. Tegmina yellowish hyaline, with whitish nervures; costa black at the base for three fourths of its length, and then brown, after an interruption, to the tip; hind margin more narrowly black for half its length; a dusky spot on the costa and inner margin before the extremity; pleura with a white waxy exudation which extends rather broadly over the sides of the pronotum and the base of the scutellum; legs testaceous (front legs rufo-testaceous), with the tips of the tibiæ and tarsi blackish.

Resembles *C. albovenosus* in many respects; but the form of the spine is very peculiar and characteristic.

Pundaloya.

\*†CENTROTUS IMITATOR, sp. n.

Long. corp. cum tegm. 5 lin.; exp. corn. 3 millim.

Deep black, thickly and rather finely punctured; pectus with white waxy efflorescence, which extends along the borders of the pronotum and invades the base of the scutellum; lateral spines moderately long and slender, almost horizontal; central spine slightly raised at the extremity and gradually curved backwards, as long as the body. Legs rufo-testaceous; coxæ black; tarsi inclining to blackish; hind legs pale testaceous. Tegmina yellowish hyaline, with whitish nervures; costa with a broad black band for three fourths of its length, towards the extremity of

which it is bordered outside with yellowish; the inner margin is also more narrowly black for some distance from the base; a narrow blackish or rufo-testaceous border extends round the rest of the wing, interrupted for a short space beyond the black stripe on the inner margin; before the tip and hinder angle is a more or less conspicuous brown spot.

Nearly allied to *C. decipiens*. I have retained Walker's MS. name for the present species.

Pundaloya.

\*†CENTROTUS CUPREUS, sp. n.

Long. corp. cum tegm. 5-6 millim.; exp. corn.  $2\frac{1}{2}$  millim.

Uniform cupreous; lateral thoracic horns short, not very acute; pectus covered with a white waxy efflorescence; usually a white dot on each side at the base of the scutellum, and another on the inner margin of the tegmina at two thirds of their length; spine slender, pointed, depressed in the middle, and extending to half the distance between the white spot on the inner margin and the tips of the tegmina. Legs rufo-testaceous. The tegmina are sometimes lighter towards the tips: one specimen has some white waxy spots near the costa at three-fifths of their length, a vitreous spot on the costa beyond, and a yellowish sub-hyaline space, marked inside with a brown spot, at the extremity of the inner margin; but these differences are hardly sufficient to be regarded as specific in the absence of a series for comparison.

Appears to be a common species in Ceylon.

Pundaloya.

ANOMUS RETICULATUS.

*Anomus reticulatus*, *Faïrm. Ann. Soc. Ent. France*, (2) iv. p. 521, pl. vii. fig. 32 (1846); *Motsch. Études Ent.* viii. p. 109 (1859).

Described from Brazil. Stated by Motschulsky to occur in Ceylon (?).

ANOMUS MUCRONICOLLIS.

*Anomus mucronicollis*, *Motsch. Études Ent.* viii. p. 109 (1859).

Described from Ceylon.

\*†ANOMUS TUBERCULATUS.

*Anomus turberculatus*, *Motsch. Études Ent.* viii. p. 109 (1859).

The specimen which I refer to this species has the thorax very thickly clothed with hair, a character which Motschulsky does not mention.

## TETTIGONIIDÆ ‡.

## \*TETTIGONIA PAULLULA.

*Tettigonia paullula*, *Walk. List Hom. Ins. B. M., Suppl.* p. 219 (1858).  
Described from Ceylon.

## \*†TETTIGONIA PUPULA, sp. n. (Plate VI. fig. 10.)

Long. corp. cum tegm. 5 millim.

Head orange-red above, with a large oval black spot on the hind border, and a smaller black spot in front, just visible from above; pronotum red on the sides in front; a middle stripe, widening behind, and the hind border black; scutellum with a wide testaceous band in the middle, and black on the sides; face and under surface of body testaceous; a stripe on each side of the face, the knees, and front tibiæ at least, red. Tegmina black for two-thirds of their length, and fuscous beyond, inclining to fusco-hyaline on the edges; the inner margin is broadly bordered with red, nearly as far as the black colour extends, and the base of the costa is also more or less red.

Pundaloya.

Closely allied to *T. paullula*, Walk., and perhaps a variety of it. The type of *T. paullula* is in very bad condition, but there are two additional black spots on the face, the scutellum is testaceous, with two black spots at the base, and the red colouring on the tegmina is either absent or obliterated.

## \*†TETTIGONIA GEMINA.

*Tettigonia gemina*, *Walk. List Hom. Ins. B. M.* iii. p. 737, n. 27 (1851).

Originally described from Java.

The exact locality of Mr. Green's specimens is not recorded.

## \*†TETTIGONIA FRONTALIS, sp. n.

Long. corp. cum tegm. 6-7 millim.

Head yellow; front with a very large oval blackish spot, extending from a little below the two black ocelli to the base of the rostrum, except on the margins. Pronotum black; tegmina purplish black, sometimes clothed with a green scaling; costa

‡ I have shown in *Proc. R. Dublin Soc.* vi. pp. 580, 581, that the type of *Tettigonia*, Linn., is an Orthopterous insect, *Gryllus verrucivorus*, L., to which the generic name must be restored. I cannot, without analyzing the generic synonymy of the *Homoptera*, discover what name should be substituted for *Tettigonia* in that suborder, and therefore retain it provisionally in the present paper.

broadly yellow; wings fuscous. Under surface black; pleura longitudinally, and abdomen transversely, lined with yellow; legs yellow; front coxæ, and hind femora nearly to the tip, black; hind tibiæ lined above with green or brown.

Pundaloya.

\*†TETTIGONIA PULCHELLA, sp. n. (Plate VI. fig. 13.)

Long. corp. 5 millim.; exp. al. 12 millim.

Vertex (except a red band behind the black ocelli and the red occipital ridge) and pronotum dirty yellow, the latter mottled with brown; scutellum forming a sharply-defined equilateral triangle; abdomen bright yellow at the base, with black markings, and black at the extremity; anal appendages bordered with red. Under surface and legs yellowish; extremity of abdomen and a line on the hind tibiæ black. Tegmina light yellowish brown, with pale pink spots and streaks bordered with black, largest and palest on the costa and inner margin; on the costa there are five blotches, the third, fourth, and fifth largest, and crossing the costal area, but all separated by small black spaces on the costa; towards the base the spotting is confused, but from the second, fourth, and fifth spots rows of about five spots (including those on the costa and inner margin) cross the tegmina, the middle spot being linear, or at least longer than the others; nearer the hind margin is another row of four spots, alternately linear and lunular, and nearest the apex is an incomplete ring, broken on the basal side. Wings light brown, with alternating lighter and darker bands.

Udagama.

\*LEDRA RUGOSA.

*Ledra rugosa*, Walk. *List Hom. Ins. B. M.* iii. p. 816, n. 13 (1851).

Described from Ceylon.

\*†LEDRA SCUTELLATA.

*Ledra scutellata*, Walk. *List Hom. Ins. B. M.* iii. p. 812, n. 6 (1851).

Described from "East Indies."

Mr. Green's specimens are without special locality.

\*†PETALOCEPHALA CONICA.

*Ledra conica*, Walk. *List Hom. Ins. B. M.* iii. p. 823, n. 30 (1851).

Described from Ceylon.

Mr. Green's specimens are from Nawalapitya.

## \*†LEDROPSIS DIMIDIATA.

*Ledropsis dimidiata*, *Stål, Öfv. Vet.-Akad. Förh.* xv. p. 452 (1858).

Described from Ceylon.

Mr. Green's specimen from Hewaietta is much darker than those previously in the Museum Collection (which were placed, without a name, under *Petalocephala*); it is olive-green, with nearly opaque tegmina, with a yellow costa.

## \*GYPONA PRASINA.

*Gypona prasina*, *Walk. List Hom. Ins. B. M., Suppl.* p. 258 (1858).

Described from Ceylon.

## \*†GYPONA STRIATA, sp. n.

Long. corp. cum tegm. 10 millim.

Yellowish green (perhaps grass-green during life); tarsi, front tibiæ, and front of the head, which is semicircular, reddish, the latter usually edged in front with black. Pronotum and scutellum transversely striated. Wings clear hyaline.

Resembles *G. prasina*, but in the latter species the front of the head is more pointed, and the pronotum is not striated.

Pundaloya.

## IDIOCERUS (?) SUBOPACUS.

*Idiocerus* (?) *subopacus*, *Motsch. Études Ent.* viii. p. 110 (1859).

Described from the mountains of Ceylon.

## PEDIOPSIS APICALIS.

*Pediopsis apicalis*, *Motsch. Études Ent.* viii. p. 110 (1859).

Described from Ceylon (Colombo).

## JASSUS FUSCONERVOSUS.

*Jassus fusconervosus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 97 (1863).

Described from Ceylon (Patannas).

## JASSUS LATRUNCULARIUS.

*Jassus latruncularius*, *Motsch. Études Ent.* viii. p. 111 (1859).

Described from Ceylon (Nura Ellia).

## JASSUS PAUPERCULUS.

*Jassus paupercula*, *Spångb. Öfv. Vet.-Akad. Förh.* xxxiv. (9) p. 35 (1878).

Described from Ceylon.

## JASSUS (?) CURTULUS.

*Jassus* (?) *curtulus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 98 (1863).

Described from Ceylon (Patannas).

\*†*ACOCEPHALUS PORRECTUS*.

*Acocephalus porrectus*, *Walk. List Hom. Ins. B. M., Suppl.* p. 262 (1858).

Described from Ceylon.

In Mr. Green's specimen from Pundaloya the head and thorax are marked with longitudinal dull orange stripes, faintly indicated in Walker's type, though not noticed in his description.

*SELENOCEPHALUS LIMBATICEPS*.

*Selenocephalus limbaticeps*, *Stål, Œfv. Vet.-Akad. Förh.* xv. p. 453 (1858).

Described from Ceylon.

*DELTOCEPHALUS RUBROLINEATUS*.

*Deltocephalus rubrolineatus*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 98 (1863).

Described from Ceylon (Patannas).

*DELTOCEPHALUS VARIEGATUS*.

*Deltocephalus variegatus*, *Motsch. Études Ent.* viii. p. 112 (1859).

Described from Ceylon (Nura Ellia).

*DELTOCEPHALUS ELONGATO-OCCELLATUS*.

*Deltocephalus elongato-ocellatus*, *Motsch. Études Ent.* viii. p. 113 (1859); *Bull. Mosc.* xxxvi. (3) p. 99 (1863).

Described from Ceylon (Colombo and Patannas).

*DELTOCEPHALUS DISTINCTUS*.

*Deltocephalus distinctus* (sic), *Motsch. Études Ent.* viii. p. 112 (1859).

Described from Ceylon (Colombo).

*DELTOCEPHALUS GUTTULATUS*.

*Deltocephalus guttulatus*, *Motsch. Études Ent.* viii. p. 113 (1859).

Described from Ceylon (Colombo).

*DELTOCEPHALUS DORSALIS*.

*Deltocephalus dorsalis*, *Motsch. Études Ent.* viii. p. 114 (1859).

Described from Ceylon (Colombo).

*DELTOCEPHALUS (?) TRANSPARIPENNIS*.

*Deltocephalus (?) transparipennis*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 100 (1863).

Described from Ceylon (Nura Ellia).



## PLATYMETOPUS LINEOLATUS.

*Platymetopus lineolatus*, *Motsch. Études Ent.* viii. p. 114 (1859).

Described from Ceylon (Nura Ellia).

## PLATYMETOPUS ARCUATUS.

*Platymetopus arcuatus*, *Motsch. Études Ent.* viii. p. 115 (1859); *Bull. Mosc.* xxxvi. (3) p. 100 (1863).

Described from Ceylon (Nura Ellia).

## THAMNOTETTIX SUBRUFUS.

*Thamnotettix subrufa*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 100 (1863).

Described from Ceylon (Colombo).

## THAMNOTETTIX FUMOSA.

*Thamnotettix fumosa*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 101 (1863).

Described from Ceylon (Patannas).

## THAMNOTETTIX NIGROBIMACULATA.

*Thamnotettix nigrobimaculata*, *Motsch. Études Ent.* xxxvi. (3) p. 101 (1863).

Described from Ceylon (Nura Ellia).

## \*†THAMNOTETTIX NIGROMACULATA.

*Pediopsis nigromaculatus*, *Motsch. Études Ent.* viii. p. 111 (1859).

*Thamnotettix nigropicta*, *Stål, Öfv. Vet.-Akad. Handl.* xxvii. p. 740 (1870); *Atkinson, Journ. As. Soc. Bengal*, lvii. p. 338 (1889).

Colombo (*Motschulsky*); Pundaloya (*Green*); Philippines (*Stål*); India, Borneo, Sumatra (*Atkinson*).

“One of the small green insects that suddenly appear towards the end of the rains (September usually) in Calcutta. During the few days that they occur they may be found at night in considerable heaps beneath the lamps in the public streets, and they disappear as abruptly as they come. *T. bipunctata*, Fabr., appears at the same time.” (*Atkinson*.)

*T. bipunctata*, though a well-known Indian species, does not seem to have been yet recorded from Ceylon.

## DIOMMA OCHRACEA.

*Diomma ochracea*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 102 (1863).

Described from Ceylon (Patannas).

## TYPHLOCYBA MACULIFRONS.

*Typhlocyba maculifrons*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 103 (1863).

Described from Ceylon (Colombo).

## CONOMETOPUS INSPIRATUS.

*Conometopus inspiratus*, *Motsch. Études Ent.* xxxvi. (3) p. 104, pl. ii. f. 22 (1863).

Described from Ceylon (Patannas).

## PSYLLIDÆ.

## DIRAPHIA (?) INDICA.

*Diraphia (?) indica*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 114, pl. ii. f. 26 (1863).

Described from Ceylon (Nura Ellia).

## LIVILLA (?) NERVOSA.

*Livilla (?) nervosa*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 114, pl. ii. f. 27 (1863).

Described from Ceylon.

## PSYLLA OCULATA.

*Psylla oculata*, *Motsch. Bull. Mosc.* xxxvi. (3) p. 115 (1863).

Described from Ceylon (Nura Ellia).

## APHIDÆ.

## APHIS COFFEÆ.

*Aphis coffeæ*, *Nietn. Enemies of Coffee Tree*, p. 16 (1861).

Described from Ceylon.

## SIPHONOPHORA ARTOCARPI.

*Siphonophora artocarp*, *Westw. Proc. Ent. Soc. Lond.* 1890, p. xxii.

Found on the bread-fruit tree in Ceylon.

## COCCIDÆ.

## \*†LECANIUM MANGIFERÆ.

*Lecanium mangiferæ*, *Green, E. M. M.* xxv. p. 249 (1889).

*Pundaloya (Green)*; also occurs in *Demerara (Douglas, Ent. M. M.* xxv. p. 251), and may be expected to occur wherever the mango is grown.

## \*†LECANIUM COFFEÆ.

*Lecanium coffeæ*, *Walk. List Hom. Ins. B. M.* iv. p. 1079, n. 58

(1852); *Nietn. Enemies of Coffee Tree*, p. 6 (1861).

Common, and destructive, in Ceylon.

## \*†LECANIUM VIRIDE.

*Lecanium viride*, *Green, Obs. on Green Scale Bug* (1886); *Ent. M. Mag.* xxv. p. 248 (1889).

Common, and highly injurious, in Ceylon.

## LECANIUM NIGRUM.

*Lecanium nigrum*, *Nietn. Enemies of Coffee Tree*, p. 9 (1861).

The largest species, but less injurious now than formerly (*Green*).

## PSEUDOCOCCUS ADONIDUM.

*Coccus adonidum*, *Linn. Syst. Nat.* i. p. 455, n. 2 (1758).

*Pseudococcus adonidum*, *Nietn. Enemies of Coffee Tree*, p. 4 (1861).

Probably a cosmopolitan species.

## \*†COCCUS (?) FLORIGER. (Plate VI. fig. 7.)

*Coccus floriger*, *Walk. List Hom. Ins. B. M., Suppl.* p. 305 (1858).

Described from Ceylon.

This and the following species appear to be among those alluded to by Nietner ('*Enemies of Coffee Tree*,' p. 5) as belonging to the genus *Dorthesia*.

## \*†COCCUS (?) LANIGER, sp. n. (Plate V. fig. 8.)

Long. corp. cum append. 16 lin.; lat. 13 lin.

Colour apparently vinaceous; but the upper surface is entirely covered with a yellowish-white flocculent mass exactly resembling sheep's wool, in the middle of which are seen a central row, and two concentric series between this and the sides, of whiter and more condensed waxy matter. Under surface with long lateral layers of white wax completely surrounding the insect, below the woolly covering of the upper side.

Pundaloya.

## EXPLANATION OF THE PLATES.

## PLATE IV.

## HEMIPTERA HETEROPTERA.

- Fig. 1. *Pentatoma taprobanensis*, Dall., p. 84.  
 2. *Zangis dorsalis*, Dohrn, p. 85.  
 3. *Callidea Rama*, Kirb., p. 76.  
 4. *Canthecona insularis*, Kirb., p. 79.  
 5. *Elasmognathus Greeni*, Kirb., p. 109.  
 6. *Homæocerus antennatus*, Kirb., p. 90.  
 7. *Rhopalus funeralis*, Kirb., p. 97.  
 8. *Pirates ypsilon*, Kirb., p. 113.  
 9. *Rhaphigaster repellens*, Kirb., p. 86.  
 10. *Capsus Ravana*, Kirb., p. 106.  
 11. *Tingis globulifera*, Walk., p. 110.  
 12. *Pentatoma* (?) *corinna*, Kirb., p. 84.

- Fig. 13. *Lygæus quadratomaculatus*, Kirb., p. 98.  
 14, 14 a. *Dicephalus telescopicus*, Kirb., p. 117.  
 15. *Bathycælia indica*, Dall., p. 85.  
 16. *Lestomerus horridus*, Kirb., p. 111.  
 17, 17 a. *Formicoris inflatus*, Kirb., p. 122.  
 18. *Dindymus Sita*, Kirb., p. 104.

## PLATE V.

## HEMIPTERA HOMOPTERA.

- Fig. 1. *Cicada apicalis*, Kirb., p. 131.  
 2. *Clonia perductalis*, Kirb., p. 161.  
 3. *Derbe* (?) *nitagalensis*, Kirb., p. 142.  
 4. *Dictyophora* (?) *egregia*, Kirb., p. 135.  
 5. *Seliza bisecta*, Kirb., p. 152.  
 6. *Phenice punctativentris*, Kirb., p. 144.  
 7. *Thracia* (?) *obsoleta*, Kirb., p. 144.  
 8. *Coccus* (?) *laniger*, Kirb., p. 175.  
 9. *Brixioides carinatus*, Kirb., p. 140.  
 10. *Microchoria aberrans*, Kirb., p. 148.  
 11. *Pomponia Greeni*, Kirb., p. 129.  
 12. *Brixia tortriciformis*, Kirb., p. 138.  
 13. *Cixius nubilus*, Walk., p. 137.  
 14. *Delphax Ernesti*, Kirb., p. 140.  
 15. *Nogodina Greeni*, Kirb., p. 158.  
 16. *Phalænomorpha* (?) *abdominalis*, Kirb., p. 151.

## PLATE VI.

HEMIPTERA HOMOPTERA (*continued*).

- Fig. 1. *Eurybrachys Westwoodii*, Kirb., p. 146.  
 2. *Elasmoscelis* (?) *radians*, Kirb., p. 149.  
 3. *Elasmoscelis platypoda*, Kirb., p. 148.  
 4. *Hotinus insularis*, Kirb., p. 132.  
 5. *Phyllyphanta albopunctata*, Kirb., p. 156.  
 6. *Phyllyphanta acutipennis*, Kirb., p. 156.  
 7. *Coccus* (?) *floriger*, Walk., p. 175.  
 8. *Pæcilopectera quadrata*, Kirb., p. 154.  
 9. *Scarpanta latipennis*, Kirb., p. 153.  
 10. *Tettigonia pupula*, Kirb., p. 169.  
 11. *Symplana viridineris*, Kirb., p. 136.  
 12. *Rhinastria bicolor*, Kirb., p. 160.  
 13. *Tettigonia pulchella*, Kirb., p. 170.  
 14. *Pæcilopectera glauca*, Kirb., p. 154.
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On the Sponge-remains in the Lower Tertiary Strata near Oamaru, Otago, New Zealand. By G. JENNINGS HINDE, Ph.D., and W. MURTON HOLMES. (Communicated by W. PERCY SLADEN, Sec. Linn. Soc.)

[Read 4th February, 1891.]

(PLATES VII.-XV.)

#### INTRODUCTION.

THE Sponge-remains described in this paper were obtained from beds of siliceous or siliceo-calcareous material of some considerable thickness, which are exposed in several localities in the vicinity of the town of Oamaru, on the east coast of the South Island of New Zealand. Specimens of this material were first sent to this country, in the early part of 1886, by Capt. F. W. Hutton, F.G.S., Professor of Geology at Christchurch, New Zealand, who described it in a letter to Prof. Rupert Jones, F.R.S., as a Radiolarian ooze containing large quantities of sponge-spicules and radiolarians. Subsequently other examples of the rock were brought over by the late Sir J. v. Haast and exhibited at the Colonial Exhibition at South Kensington, and fragments of it were freely distributed to those interested in microscopic research. On examination, the rock proved to be extraordinarily rich not only in the organisms referred to by Capt. Hutton, but in diatoms as well, and these last-named forms have since been carefully worked out and described by Messrs. Grove and Sturt in the *Journal of the Quekett Microscopical Club* \*. These authors have enumerated 283 different forms, 107 of which are new species or varieties. From the great abundance and variety of these organisms, the beds have been regarded as a diatomaceous deposit, but it is evident that the rock contains such a commixture of sponge-remains, radiolarians, and diatoms, that it can just as appropriately be designated after one of these forms of life as after another.

From information supplied by Capt. Hutton, and from an account of the deposit given by Mr. H. A. de Lautour in the *Transactions of the New Zealand Institute* †, it appears that the principal exposures of this siliceous rock are Cormack's siding in

\* Ser. 2, vols. ii. & iii., 1886-87.

† Vol. xxi. 1888, pp. 293-311, pls. xviii.-xxiii.

Cave Valley, and Jackson's paddock and Bain's farm in the adjoining Waiarekei Valley, about four miles from Oamaru. At Jackson's paddock the beds have a thickness of from 40 to 60 feet. They are immediately overlain by the well-known Ototara limestone, and they rest on beds of volcanic rock. In some places also the deposit is traversed by volcanic dykes, which have had the effect of hardening and partially fusing the siliceous material in their vicinity. There is some difference of opinion amongst New Zealand geologists as to the relative age of this Ototara limestone and the siliceous beds beneath it. By Sir Jas. Hector, F.R.S. \*, they are considered to be of Cretaceo-Tertiary age, about the horizon of the Lower Eocene; Capt. Hutton †, on the other hand, places them in the Upper Eocene or Oligocene, and this latter view is probably approximately correct.

In general appearance the specimens of this Oamaru material which have been sent to this country very much resemble our Upper White Chalk; they are, when dry, of a greyish-white tint, soft, earthy, friable, and readily breaking up into a fine mud of a creamy tint in water. Unlike the chalk, however, most of the specimens appear to be entirely siliceous, and show no reaction with acid, but in some there is a small proportion of calcareous material. In the rock unaltered by heat, the different kinds of microscopic organisms of which it is composed are heterogeneously intermingled together, and the individual forms are either entirely free from each other, or lightly cemented by an impalpably fine material formed mainly by the comminuted skeletal débris of the diatoms and radiolarians, so that by careful manipulation these organisms may be obtained free from matrix. The deposit seems to be nearly wholly of organic origin; no sand or other coarse materials of mechanical derivation can be distinguished in it. The distribution of the different kinds of organisms is by no means uniform throughout the deposit, for while some specimens consist chiefly of diatoms with a few radiolaria and the minuter forms of sponge-spicules, in others the spicules are relatively large and there is only a slight admixture of diatoms. It has also been noticed that certain genera of diatoms are abundant in some portions of the rock and very rare in others. In the partially calcareous portions, foraminifera are also present, and it is evident

\* Report 1876-7 Geological Survey of New Zealand, pp. iv, 48.

† Geology of Otago, 1875, p. 54.

that the small quantity of carbonate of lime occasionally occurring in the rock is due to the tests of these organisms.

The general character and composition of this Oamaru siliceous rock show a close resemblance to those pelagic deep-sea deposits discovered by the 'Challenger' Expedition, which have been described under the names of Diatom and Radiolarian oozes. As in these oozes, the Oamaru rock is largely made up of minute organisms in varying proportions; sometimes the diatoms preponderate, in others radiolarians are abundant, whilst throughout there is so considerable an admixture of sponge-spicules that the rock might fairly be termed a sponge-bed. In the recent oozes sponge-spicules also appear to be generally present; there is further, in the majority of these deep-sea deposits, a small number of foraminifera, and these organisms are also present, but not in any great proportion, in some specimens of the Oamaru rock, whilst in others there are no traces of them and the rock is wholly siliceous. The absence of coarse arenaceous materials is the same in the Oamaru as in the recent deep-sea ooze. We may therefore conclude that this Oamaru rock was a deep-sea deposit, formed at some considerable distance from land, and that it may rightly be compared with the Diatom ooze which now forms a belt of varying width surrounding the South Polar Regions, and extending from the Antarctic Circle to about lat.  $40^{\circ}$  S. This recent Diatom ooze has a range in depth of from 600 fathoms to 1975 fathoms, with an average, according to the 'Challenger' Report\* lately issued, of 1477 fathoms. The large proportion of radiolaria in some of the Oamaru specimens may even indicate a greater depth than that of a more distinct Diatom ooze; and this supposition is to a certain extent confirmed by the character of some ooze dredged up by H.M.S. 'Egeria' from depths of 2479 and 3000 fathoms in lat.  $36^{\circ} 53'$  S., long.  $115^{\circ}$  E., and lat.  $36^{\circ} 08'$  S., long.  $117^{\circ} 10'$  E., respectively. This area is off the south-west coast of Australia. In this ooze there are numerous detached sponge-spicules with radiolaria, and many of the former are closely allied to those from Oamaru.

There is a very great contrast between this siliceous Oamaru deposit and that which, according to the 'Challenger' Report, is now forming off the east coasts of New Zealand at depths of from 700 to 1100 fathoms. This recent deposit is a blue mud

\* Deep-Sea Deposits.

with from 4 to 10 per cent. of carbonate of lime, and it consists chiefly of amorphous and clayey matter and fine mineral particles from the neighbouring land, whilst there are very few siliceous organisms in it.

The only *fossil* deposit which nearly resembles in character the Oamaru rock is the so-called Radiolarian rock of Barbados. In this, however, the radiolaria preponderate, but diatoms also are abundant and many of the forms are, according to Messrs. Grove and Sturt, identical with those in Oamaru. Some characteristic sponge-spicules are also common to these widely-separated deposits, but, so far as we are aware, the sponge-remains in the Barbados rock have as yet not been systematically studied.

#### MINERAL AND OTHER CONDITIONS OF THE SPONGE-REMAINS.

As a rule, in the rock unaltered by heat, but little chemical change appears to have taken place in the siliceous skeletons of which it is composed. The sponge-spicules, radiolaria, and diatoms retain, for the most part, the same smooth, brilliant, glassy appearance as in existing forms. In a few instances, however, this clear glassy aspect is replaced by a dull milk-white tint, and the spicules thus changed are precisely similar in structure to the least-altered fossil forms occurring in the Upper Greensand Sponge-beds at Warminster, Wiltshire \*, and in the Westphalian beds of the age of the Upper Chalk described by v. Zittel †. Occasionally also spicules are met with traversed throughout by minute curved cracks or lines like those already ‡ described in certain of the Upper Greensand beds of this country. But in both the glassy and milk-white conditions the silica of the spicules retains the colloid or opalized state, and no instance has been observed in which it has passed into the form of chalcedony, as is generally the case with fossil spicules from the Cretaceous and older rocks. The few instances in which change from the glassy to the milk-white state has taken place tend to show that the unusually perfect condition of preservation is due to the more recent age of the beds and to specially favourable circumstances of fossilization. It may be said that, as a whole, the condition of these Oamaru spicules differs hardly at all from that of the detached spicules brought up by the dredge

\* Phil. Trans. vol. clxxv. pt. ii. 1885, p. 426.

† "Ueber Cœloptychium," Bay. Akad. d. Wiss. B. xii. Abth. iii. p. 29.

‡ Phil. Trans. l. c. p. 426, pl. 40. figs. 8, 9.



from the present sea-bottom. Even in these recent spicules there is often an enlargement of the axial canals due to a partial solution of the spicular walls, and similarly enlarged canals are likewise shown in these fossil forms. Not infrequently the enlarged canals in the fossil forms have been infilled with a greenish mineral which now appears as a slender axial rod distinct from the spicular wall, and in some cases this rod has subsequently been contracted and contorted within the spicule so as to resemble a foreign vermiform body. In many instances also the Oamaru spicules have suffered from the peculiar borings in their walls so common in spicules from the deep-sea deposits\*.

Not only have these Oamaru sponge-spicules retained their original structure of opalized silica, but their forms have to a great extent been preserved intact, with their surface adornment of spines, &c., to the minutest microscopic detail. They have naturally suffered less from mechanical pressure than the more delicate diatoms and radiolaria whose broken up fragments mainly form the finer portions of the rock.

In describing the sponge-remains in this deposit we are necessarily limited to the characters shown by the detached spicular elements of these organisms, which are now indiscriminately mingled together in the rock. Notwithstanding the great abundance of these detached spicules, and the fact that they belong to a great variety of sponges, no entire specimen of a fossil sponge, nor even a connected fragment, appears as yet to have been discovered in these beds. It is fairly certain that the sponges lived and died at considerable ocean depths, and thus were not likely to be exposed to any great disturbing influences from currents; and yet their skeletons seem to have been thoroughly disintegrated, so that it is rare to find even two or three of their spicules still in their natural association with respect to each other. Not only is this the case with monactinellid and tetractinellid sponges, whose spicules are merely held in position by the soft animal structures, but it is equally true with the spicules of lithistid sponges, and still more strange with the connected meshwork of hexactinellids, which occurs broken up into microscopic fragments. There is consequently no clue to the form or canal-structure of the sponges to which these spicules belonged, and the only comparison available is that of the relative similarity of the individual spicules with those of

\* See Duncan, Journ. R. Micr. Soc. ser. 2, vol. i. (1881), p. 557, pls. vii., viii.

other fossil and existing sponges. But as recent sponges are mainly classified according to the characters of their spicules, we are able, from the study of these fossil forms, to gain a knowledge of the genera and species of these organisms represented in this rock. The excellent state of preservation of the spicules in this material is a great advantage for their study, and still more important is the fact that very many of the minuter forms or so-called flesh-spicules have been preserved. These latter are of very rare occurrence in the fossil state, and their number and variety of form in this deposit exceed by far what has hitherto been recorded.

A comparison of these Tertiary New Zealand spicules with those of recent sponges described by Carter, Oscar Schmidt, Bowerbank, and other spongologists, and more especially with those figured in the 'Challenger' Reports on these organisms, shows on the whole a remarkable similarity between them; the differences are mainly in details of size and form, such as would indicate specific rather than generic or family variation. A striking feature in the Oamaru deposit is the extraordinary commingling of representatives of different divisions of sponges to an extent greater than has been proved to exist in other similar fossil deposits.

To a great extent our comparison of the fossil with recent spicules has been necessarily limited to those of known sponges, for no attempt has been made to study or describe the *detached* spicules which are so numerous in recent deep-sea deposits, and from what we have seen of those obtained by the 'Egeria' it is certain that many belong to sponges which are as yet unknown to science.

Many of the forms in the Oamaru deposit have their nearest existing allies living in the Indian Ocean and in the Australian Seas, but the relations of some others are now only known from areas widely separate from New Zealand: thus, for example, the genus *Guitarra*, Carter, fairly well represented at Oamaru (Pl. XI. figs. 1-7), has hitherto only been known from the Gulf of Mexico and the North Atlantic.

Though it is probable that most of the spicules referred to later on belong to species not hitherto described, it has not seemed desirable to apply trivial names to them except in a few instances where the forms are very markedly different from those of species already known. We propose to treat these

spicules under the groups of the Monactinellidæ, Zittel (or Monaxonida, Ridley & Dendy), Tetractinellidæ, Marshall, Lithistidæ, Osc. Schmidt, and Hexactinellidæ, Osc. Schmidt.

# I. MONACTINELLIDÆ, Zittel (= Monaxonida, Ridley & Dendy).

In this division, which appears to have been more numerous represented than any other, the characteristic acerate, cylindrical, acuate, and pin-shaped skeletal spicules are very abundant and exhibit numerous gradations of size, and there is a considerable variety of the anchorate, hook-shaped, and sceptre-like flesh-spicules. The skeletal spicules of this group are as a rule such simple forms and common to so many genera as to be of little service in classification, but the minuter flesh-spicules, many of which are so small as to require to be figured on the scale of 600 diameters, afford good generic and specific indications. Hitherto so little has been known of fossil sponges of this group, that it has been supposed that they did not exist in any numbers in earlier epochs; but the evidence from this deposit shows that in the New Zealand region they abundantly flourished during the Early Tertiary period, and that they were proportionately as numerous and as varied as at the present day.

## *Skeletal Spicules of Reniera, Chalina, and allied Genera.*

Pl. VII. figs. 1, 2. Smooth acerates, slightly curved, slender, ranging from .106 to .15 mm. in length by .005 to .009 mm. in thickness.

Pl. VII. figs. 3-8. Smooth acerates, curved, fusiform, stouter than the preceding, varying between .145 and .37 mm. in length by .013-.03 mm. in maximum thickness. Spicules of similar forms and proportions to these are very generally present in existing species of *Reniera* and *Chalina*.

Pl. VII. figs. 9, 10. Smooth, slender acerates, fusiform, very elongate, straight or sinuous, one end sometimes tapering more rapidly than the other. Length .9-1.14 mm. by .015-.02 mm. in thickness. Similar spicules are figured by Ridley and Dendy in *Halichondria latrunculioides* (Chall. Rep. vol. xx. p. 6, pl. ii. fig. 1), from off the Rio de la Plata at a depth of 600 fathoms.

Pl. VII. figs. 11-13. Acerate spicules with nearly straight, smooth, cylindrical shafts and abruptly-pointed extremities.

Length ·12–·3 mm. by ·013–·024 mm. in thickness. Spicules similar to fig. 13 but less robust occur in *Cladochalina nuda*, var. *abruptispicula*, Ridley ('Alert' Rep. (1884) p. 396, pl. xli. fig. j), from Torres Straits.

Pl. VII. figs. 31–36. Cylindrical spicules, smooth, evenly curved, with rounded non-inflated ends. They are of very varying length, the smaller forms so reduced as to become reniform (fig. 32). The axial canals but seldom shown. Length from ·025 to ·195 mm. by ·014–·03 mm. in thickness. Spicules of this type are common as fossils from the Carboniferous formation upwards, but the older forms are generally much larger than the Tertiary and Recent. A recent sponge with similar spicules from the Gulf of Manaar is referred by Carter to *Reniera* (Ann. & Mag. N. H. s. 5, vol. vi. p. 48, pl. v. fig. 18).

Pl. VII. fig. 46. Cylindrical, smooth, nearly straight, ends evenly rounded, to a slight degree thicker near the ends than in the central portion of the spicule. Length ·37 mm. by ·02 mm. in thickness. Spicules of this type are present in *Reniera*, *Myxilla*, and other genera. The spicules of the existing *Reniera cratera*, Osc. Sch. (Spong. Adriat. p. 73, pl. vii. fig. 7), are closely similar.

Pl. VII. figs. 45, 47. Cylindrical, smooth, elongate, slightly curved, ends obtuse or rounded. Length ·26 to ·37 mm. by ·005 to ·006 mm. in thickness. Similar but slightly larger spicules are present in *Raspailia tenuis*, Ridley & Dendy (Chall. Rep. vol. xx. p. 188, pl. xl. fig. 8b), from near Bahia in shallow water, and they occur detached in dredgings from off the S.W. coast of Australia, at a depth of 2479 fathoms.

Pl. VII. figs. 23–25. Smooth, fusiform, acerate spicules, straight or slightly curved, with a well-marked central bulbous inflation. The axial canal is continuous throughout the spicule, with a very slight central inflation. Length from ·1 to ·32 mm. by ·013–·03 mm. in thickness. Similar spicules are figured by Bowerbank in *Isodictya anomala* (Mon. Brit. Spong. iii. pl. l. fig. 3) and by Carter in *Halichondria aceratospiculum* (Ann. & Mag. N. H. s. 5, vol. vi. pl. v. fig. 19b); also by Hansen in *Cladorhiza abyssicola*, Sars (Norw. North-Atl. Exp., Spong. pl. iv. fig. 4).

#### *Spined Skeletal Spicules of various Genera.*

Pl. VII. fig. 15. Fusiform, curved, very gradually tapering, thickly spined throughout; spines small, without arrangement. Axial canal opening at both ends. Similarly spined but smaller

spicules occur in *Halichondria infrequens*, Carter (Ann. & Mag. N. H. s. 5, vol. vii. 1881, p. 369, pl. xviii. fig. 9 a), from the Gulf of Manaar.

Pl. VII. fig. 16. Acerate, fusiform, nearly straight, gradually tapering to acutely pointed extremities. Surface with strong stout spines projecting at right angles, irregularly distributed. Length .076 mm. by .014 mm. in thickness, including the spines. Similar spicules are present in *Sclerilla dura*, Hansen (Norw. North-Atl. Exp., Spong. pl. ii. fig. 5).

Pl. VII. fig. 17. Acerate, fusiform, slightly arcuate, ends abrupt and very acute. Spines disposed verticillately, the largest in the central portion are directed outwards, those near the ends are slightly recurved. Length .14 mm., thickness .025 mm.

Pl. VII. fig. 18. Acerate, fusiform, a slight inflation in the centre, from which the straight rays diverge at an open angle. A continuous axial canal. Spines very small, sparsely and irregularly distributed. Length .14 mm., thickness .015 mm. Rare. Spicules similar in form but without spines occur in *Halichondria aceratospiculum*, Carter, from the Gulf of Manaar (Ann. & Mag. N. H. s. 5, vol. vi. 1880, p. 49, pl. v. fig. 19 b).

Pl. VII. figs. 19, 22. Acerate, fusiform, with a strongly-marked bend in centre, acutely pointed. Spines numerous, small, blunted, irregularly distributed, projecting at right angles. Length .175 mm., thickness .015 mm. Similar but slightly smaller spicules are present in the dermal membrane of *Hymedesmia inflata*, Bow. (Mon. Brit. Spong. vol. iii. p. 248, pl. 79. fig. 8), from Shetland.

Pl. VII. fig. 20. Curved acerate, nearly cylindrical throughout its length, with abruptly pointed ends. Surface thickly covered with small irregularly distributed spines, which are more numerous near the centre than at the ends of the spicule. Length .2 mm., thickness .011 mm.

Pl. VII. fig. 21. Slender, fusiform, slightly contort, gradually tapering to acute points; surface annulated with smooth rings, those near the ends minutely tuberculate. Length .255 mm., thickness .01 mm. Mr. Carter figures similarly annulated spicules in *Hymerhaphia eruca* (Ann. & Mag. N. H. s. 5, vol. vi. p. 46, pl. iv. fig. 9 b), from the Gulf of Manaar.

Pl. VII. fig. 41. Acerate spicule with straight subcylindrical or subfusiform shaft and obtusely conical extremities. The shaft has irregularly scattered stout spines—those in the centre

projecting directly outwards; near the ends the spines are smaller and oblique in direction. Length  $\cdot 21$  mm., thickness (including spines)  $\cdot 04$  mm.

Pl. VII. fig. 27. Subcylindrical spicule, irregularly curved, ends obtusely rounded; surface with small spines irregularly distributed but more numerous near the ends. Length  $\cdot 17$  mm., thickness  $\cdot 024$  mm. Rare.

Pl. VII. fig. 28. Spicule subcylindrical, bent so that the rays form a slight angle at the centre, ends blunted and spined. Surface verticillately spined; the spines short, conical, projecting directly outwards. Axial canal with a distinct central bend, closed at both ends of the spicule. Length  $\cdot 21$  mm., thickness  $\cdot 022$  mm.

Pl. VII. fig. 29. Subcylindrical spicule, slightly curved and somewhat thicker in the central portion, ends evenly rounded and spined, surface verticillately spined; the verticils closer near the ends, spines minute. Length  $\cdot 23$  mm., thickness  $\cdot 015$  mm.

Pl. VII. fig. 30. Cylindrical, slightly curved spicules with evenly rounded ends; spines short, blunted, disposed in verticils at about equal distances apart; ends thickly spined. Length  $\cdot 135$  mm., thickness  $\cdot 013$  mm. Mr. Carter has figured a similar spicule from an unknown sponge from the Gulf of Manaar (Ann. & Mag. N. H. s. 5, vol. vi. 1880, pl. v. fig. 29).

Pl. VII. fig. 40. Cylindrical, evenly curved, ends evenly rounded and very thickly spined; spines irregularly distributed. Length  $\cdot 085$  mm., thickness  $\cdot 012$  mm.

Pl. VII. fig. 38. Spicule subcylindrical, slightly inflated in the centre, ends obtusely rounded; surface with spiral ridges or crests of minute tubercles or spines, the ends likewise spined. Length  $\cdot 16$  mm., thickness  $\cdot 02$  mm. Similar spicules have been figured by Mr. Carter in *Dotona pulchella*, from the Gulf of Manaar (Ann. & Mag. N. H. s. 5, vol. vi. p. 57, pl. v. fig. 24).

*Dumb-bell Skeletal Spicules of Plocamia, Osc. Schmidt.*

Pl. VII. fig. 37. Cylindrical, slightly curved, with inflated ends. The shaft is quite smooth, whilst the ends are very minutely spined or tuberculate. Length  $\cdot 095$  mm., thickness  $\cdot 015$  mm. This spicule resembles those in *Plocamia (Dictyocylindrus) manaaensis*, Carter, sp. (Ann. & Mag. N. H. s. 5, vol. vi. 1880, p. 37, pl. iv. fig. 1 c), but it is not more than half the length. See also Ridley (Journ. Linn. Soc., Zool. vol. xv. 1881, p. 482).

Pl. VII. fig. 39. Cylindrical, curved, ends slightly inflated. The entire surface thickly set with small spines. Length  $\cdot 125$  mm., thickness  $\cdot 014$  mm.

Pl. VII. fig. 51. Cylindrical, with straight shaft and curved ends. The straight portion has stout conical spines projecting directly outwards, whilst the ends are evenly rounded and smooth. Length  $\cdot 16$  mm., thickness  $\cdot 02$  mm.

*Spicules of Alectona, Carter.*

Pl. VII. fig. 44. Acerate spicule, bent in the middle, slowly tapering to the ends, which are obtuse and spined. Surface with numerous stout spines which have an apparent linear arrangement. The axial canal extends throughout the spicule and opens at the ends. Length  $\cdot 35$  mm., thickness  $\cdot 035$  mm. This form has the same general characters as the large spicules of *Alectona Millari*, Carter (Journ. R. Micros. Soc. vol. ii. 1879, p. 494, pl. xvii. fig. 3), from the North Atlantic at a depth of 363 fathoms. Detached spicules of the same form but with larger nodes are present in dredgings from off the S.W. coast of Australia at a depth of 2479 fathoms.

Pl. VII. fig. 26. Fusiform acerate, evenly tapering to both ends; in the central portion of the spicule a few scattered spines. Length  $\cdot 077$  mm., thickness  $\cdot 01$  mm. This form may be compared with the subskeletal flesh-spicules of *Alectona Millari*, Carter (l. c. pl. xvii. fig. 4).

*Skeletal Spicules of Hymeniacidon* (?), Bow.

Pl. VII. figs. 42, 43. Subcylindrical spicules with obtuse ends, armed throughout with stout, short, conical, acutely pointed spines, without definite arrangement. Length  $\cdot 17$  mm., thickness from  $\cdot 05$  to  $\cdot 08$  mm. Spicules of the same character but smaller have been figured by Bowerbank in *Hymeniacidon Cliftoni* (Mon. Brit. Spong. vol. i. pp. 233, 276, pl. i. fig. 33, pl. xvii. fig. 291), from Freemantle, Western Australia.

*Skeletal Spicules of Axinella, Osc. Schmidt.*

Pl. VII. fig. 52. Spicules subcylindrical, vermicular, smooth, with obtusely rounded ends. Length  $\cdot 29$  mm., thickness  $\cdot 015$  mm. Similar spicules are figured by Ridley and Dendy in *Axinella erecta*, Carter, sp. (Chall. Rep. vol. xx. p. 182, pl. xl. fig. 1 a), from off Crozet Island, at depths between 550 and 1600

fathoms, and according to Mr. Carter this species is likewise plentiful in the Gulf of Manaar (Ann. & Mag. N. H. s. 5, vol. vi. 1880, p. 46) and also at various depths in the Atlantic.

*Tibiella Spicules of Myxilla, O. Schmidt, and other Genera.*

Pl. VII. fig. 14. Slender, regularly curved, fusiform spicule, gradually tapering to either end and terminating with a conical or lance-shaped inflation. Length .45 mm., thickness .01 mm. Spicules of a similar character but slightly larger are present in *Histodermæ appendiculatum*, Carter (Ann. & Mag. N. H. s. 4, vol. xiv. 1874, p. 220, pl. xv. fig. 39 b), from the depths of the Atlantic.

Pl. VII. fig. 48. *Tibiella* stout, curved, fusiform, tapering gradually to each end and with inflated ovoidal extremities. Length .61 mm., thickness .032 mm. This is both larger and stouter than the preceding, and the inflated ends likewise differ.

Pl. VII. fig. 49. *Tibiella* subfusiform, curved, with evenly rounded club-shaped terminations, not constricted near the ends. Length .37 mm., thickness .012 mm.

Pl. VII. fig. 50. Stout, slightly curved, fusiform *tibiella*, with ovoid terminal expansions. Slightly constricted near the ends. Length .72 mm., thickness .06 mm.

Pl. VIII. fig. 1. *Tibiella* with smooth, nearly evenly cylindrical, curved shaft and elongate club-shaped terminations. Length .412 mm., thickness .017 mm.

Pl. VIII. fig. 2. Slender, smooth, slightly undulating cylindrical shaft with clavate terminations. Length .365 mm., thickness .006 mm. Spicules similar in form but slightly larger are present in *Forcepia colonensis*, Carter (Ann. & Mag. N. H. s. 5, vol. xv. 1885, p. 110, pl. iv. fig. 2 a), from off Port Phillip Heads, Australia, at a depth of 19 fathoms.

Pl. VIII. fig. 3. *Tibiella* with elongate, cylindrical, irregularly curved shaft and prominent club-shaped ends. Length .765 mm., thickness .008 mm. Slightly shorter, but otherwise similar spicules occur in *Phlæodictyon birotuliferum*, Carter (Ann. & Mag. N. H. s. 5, vol. xviii. p. 447, pl. x. fig. 2 b), from off Western Australia.

Pl. VIII. fig. 4. Very slender *tibiella* with curved cylindrical shaft and elongate club-shaped terminations. Length .215 mm., thickness .003 mm. Very similar spicules are present in *Halichondria infrequens*, Carter (Ann. & Mag. N. H. s. 5, vol. vii. 1881, p. 369, pl. xviii. fig. 9 b), from the Gulf of Manaar.



Pl. VIII. fig. 5. Tibiella with smooth, evenly cylindrical, regularly curved shaft and prominent club-shaped ends. Length  $\cdot 133$  mm., thickness  $\cdot 003$  mm.

Pl. VIII. fig. 6. Tibiella with smooth, cylindrical, slightly curved shaft and club-shaped extremities which are minutely spined. Length  $\cdot 106$  mm., thickness  $\cdot 003$  mm. Similar spicules occur in *Iophon cylindricus*, Ridley & Dendy (Chall. Rep. vol. xx. p. 120, pl. xvii. fig. 6 c), from off Cape Howe, Australia, at a depth of 120 fathoms.

The examples of tibiella spicules figured above indicate a considerable variety of form and size in the Oamaru material and they are likewise very abundant. They range from  $\cdot 106$  to  $\cdot 765$  mm. in length, and from  $\cdot 003$  to  $\cdot 06$  mm. in thickness. Tibiella spicules are present in the following genera, amongst others, of recent sponges:—*Histoderma*, Carter, *Tedania*, Gray, *Iophon*, Gray, *Myxilla*, Osc. Sch., *Forcepia*, Carter, *Sideroderma*, Ridley & Dendy, and also in some of the species placed under *Hali-chondria* by Carter and Bowerbank, and in *Phlæodictyon*, Carter. It will be shown further on that the distinctive flesh-spicules of several of these genera are present in the deposit. Detached tibiella spicules are present in dredgings off the S.W. coast of Australia at a depth of 2479 fathoms.

#### *Acuate or Styliform Spicules of various Genera.*

Pl. VIII. fig. 7. Acuate, with evenly rounded head, the upper half of the shaft nearly of an even thickness, then gradually tapering to an acute point. Length  $\cdot 385$  mm., thickness  $\cdot 008$  mm.

Pl. VIII. fig. 8. Large, stout, slightly curved acuate, of an even thickness for about two-thirds from the head, thence gradually tapering. Axial canal widest near the head and gradually diminishing to the apex. Length  $1\cdot 5$  mm., thickness  $\cdot 036$  mm. This is the largest form of acuate met with in the deposit. Shorter but otherwise similar spicules are present in *Amphilectus annectens*, Ridley & Dendy (Chall. Rep. vol. xx. p. 127, pl. xix. fig. 4), and also in *A. pilosus*, R. & D. (l. c. p. 126, pl. xix. fig. 5), from Kerguelen.

Pl. VIII. fig. 9. Nearly straight acuate, of approximately the same thickness to within a short distance of the apex. The head is slightly inflated but hardly sufficient to include it with spinulate forms. Length  $\cdot 285$  mm., thickness  $\cdot 006$  mm.

Pl. VIII. fig. 10. Slightly curved acuate, very gradually tapering from the head to the acutely-pointed apex. Length  $\cdot 665$  mm., thickness  $\cdot 017$  mm.

Pl. VIII. fig. 10 *a*. Robust, short, nearly straight acuate, nearly cylindrical throughout, abruptly pointed near the apex. Length  $\cdot 54$  mm., thickness  $\cdot 04$  mm.

Pl. VIII. figs. 11, 12. Evenly curved acuates, heads rounded, thickest in central portion of the shaft, tapering in lower third, somewhat abruptly pointed. Length  $\cdot 56$  to  $\cdot 6$  mm., thickness  $\cdot 03$  mm. Similar but slightly larger forms are present in *Myxilla hastata* and *M. spongiosa*, Ridley & Dendy (Chall. Rep. vol. xx. p. 134, pl. xxvii. figs. 1, 3), from off the mouth of the Rio de la Plata at a depth of 600 fathoms.

Pl. VIII. figs. 13, 14. Short curved acuates, thickest a short distance below the head, tapering from the lower third. Length of fig. 13,  $\cdot 352$  mm., thickness  $\cdot 02$  mm. Fig. 14, length  $\cdot 175$  mm., thickness  $\cdot 01$  mm. In this latter the axial canal is widened for a short distance below the head, whilst in fig. 13 it appears as an extremely fine even thread throughout its length.

Pl. VIII. fig. 15. Slender, elongate, slightly curved acuate, shaft thickest a little below the middle of the spicule; near the apex it tapers somewhat abruptly. Length  $\cdot 485$  mm., thickness  $\cdot 009$  mm.

Pl. VIII. figs. 16–20. Short, stout, curved, comma-shaped acuates, tapering from the middle, thickest at or near the head. Length  $\cdot 095$  to  $\cdot 58$  mm., thickness  $\cdot 015$  to  $\cdot 04$  mm. Though varying considerably in dimensions, these forms exhibit similar characters. Spicules of corresponding form and size occur in *Axinella spiculifera*, Lam., sp., and in *A. proliferans*, Ridley ('Alert' Report, pp. 617–8, pl. liv. figs. *b*, *c*), the former from King Island, Australia, the latter from Providence Island, Mascarene Group, at depths of from 18 to 22 fathoms.

Pl. VIII. fig. 41. Curved acuate, nearly uniformly cylindrical throughout, abruptly pointed near the apex. Length  $\cdot 37$  mm., thickness  $\cdot 01$  mm.

Pl. VIII. figs. 22, 23. Straight acuates, fusiform, summits evenly rounded, shafts increasing in thickness to near or below the centre, thence gradually tapering to the apex. Length  $\cdot 36$  to  $\cdot 5$  mm., thickness  $\cdot 016$  to  $\cdot 021$  mm. These forms have the same general appearance as the skeletal spicules of *Tethya*, Lam., but they are much smaller.

Pl. VIII. fig. 30. Acuate spicule, with the upper portion curved like a walking-stick, at right angles to the rest of the shaft. Head evenly rounded and thick, thence gradually tapering to the apex. The axial canal follows the curve of the head. Length  $\cdot 31$  mm., thickness  $\cdot 025$  mm.

*Smooth Acuates with Bulbous Shafts.*

Pl. VIII. figs. 39, 40. Approximately straight spicules, fusi-form or styli-form, with rounded or blunt heads, the top portion of the shaft even, below this with several bulbous inflations at irregular distances, the apices acutely pointed. The axial canal is even throughout the spicule and not inflated. Length  $\cdot 53$  to  $\cdot 7$  mm., greatest thickness of shaft  $\cdot 02$ , of inflated portion  $\cdot 028$  mm. Similarly inflated spicules occur in *Phelloderma radium*, Ridley & Dendy (Chall. Rep. vol. xx. p. 113, pl. 23. figs. 8, 8 a), from off the mouth of the Rio de la Plata at a depth of 600 fathoms.

*Spined Acuate Spicules.*

Pl. VIII. fig. 24. Elongate slender acuate, very gradually tapering from the summit, the head thickly set with minute spines or tubercles; the rest of the shaft smooth. Length  $\cdot 62$  mm., thickness  $\cdot 012$  mm.

Pl. VIII. fig. 25. Straight acuate, very gradually and evenly tapering from the summit to the apex; upper portion of shaft smooth, the rest covered with very minute spines. Length  $\cdot 51$  mm., thickness  $\cdot 028$  mm.

Pl. VIII. figs. 26, 33. Curved acuates, nearly of an even thickness in the upper two-thirds of the shaft, then tapering slightly, abruptly pointed. Surface with very short conical spines projecting at right angles, smooth near the apex. Length  $\cdot 165$  to  $\cdot 215$  mm., thickness  $\cdot 015$  mm. Nearly similar forms are figured in *Halichondria Dickiei*, Bow. (Mon. Brit. Spong. vol. iii. pl. xlv. fig. 4).

Pl. VIII. fig. 27. Curved acuate, thickest in central portion, abruptly pointed; surface thickly set with stout conical spines projecting at right angles. Length  $\cdot 265$  mm., thickness  $\cdot 025$  mm.

Pl. VIII. fig. 28. Curved acuate, slightly inflated at the summit, tapering gradually in the lower half; surface covered with numerous short spines. Length  $\cdot 245$  mm., thickness  $\cdot 019$  mm.

Pl. VIII. fig. 21. Short, strongly curved acuate, upper half evenly cylindrical, then gradually tapering, abruptly pointed. Spines small, conical, numerous. Length  $\cdot 12$  mm., thickness  $\cdot 01$  mm.

Pl. VIII. fig. 34. Slightly curved acuate, gradually tapering from the rounded summit; surface evenly covered with minute spines. Length  $\cdot 185$  mm., thickness  $\cdot 015$  mm.

Pl. VIII. figs. 35, 36. Elongate acuate, upper portion curved with slightly inflated summit, lower two thirds nearly straight, gradually tapering to an acute point. In the upper portion short slightly hooked spines; in the lower the spines are smaller and sparsely distributed. Length  $\cdot 51$  mm., thickness  $\cdot 015$  mm. Fig. 36 is straight, spined like fig. 35.

Pl. VIII. fig. 30a. Stout acuate, the upper portion bent nearly at right angles, thickest at the head; from thence gradually tapering to the apex, which is abruptly pointed. The bent portion of the shaft is smooth, the rest with minute conical spines; near the apex there are small, thickly set, recurved spines. Length  $\cdot 235$  mm., thickness  $\cdot 02$  mm. Mr. Carter figures spined acuates of similar form, but larger, in *Microciona intexta* (Ann. & Mag. Nat. Hist. s. 4, vol. xviii. 1876, p. 239, pl. xv. fig. 43a).

Pl. VIII. fig. 31. Acuate spicule with the upper portion strongly curved like a walking-stick, and furnished with minute spines; in the straight lower portion of the shaft the spines are fewer and smaller. Length  $\cdot 115$  mm., thickness  $\cdot 014$  mm.

As shown in the figures on Pl. VIII., acuate spicules, whether smooth or spined, are very abundant in the Oamaru deposit; and they exhibit considerable variations in size, ranging in length from  $\cdot 095$  to  $1\cdot 5$  mm., and in thickness from  $\cdot 006$  to  $\cdot 04$  mm. The greater number, however, range in length between  $\cdot 2$  and  $\cdot 5$  mm., and they correspond very closely in this respect with the acuate spicules of existing sponges. Acuate spicules are present in numerous genera of recent sponges; the most important of these are *Esperella*, *Iophon*, *Esperiopsis*, *Amphilectus*, *Myxilla*, *Axinella*, and *Latrunculia*; also in some species placed by Bowerbank and Carter under *Halichondria*, *Dictyocylindrus*, *Hymeniacidon*, &c. Several of the above-named genera can be recognized in the Oamaru material by their distinctive flesh-spicules, to be described later.

Fossil acuate spicules are known from the Carboniferous limestone; they are also present in Jurassic and Cretaceous strata;

but they are rare forms, and considerably larger than those present in this deposit. Detached acuate spicules occur in dredgings off the S.W. of Australia, taken by H.M.S. 'Egeria' from a depth of 3000 fathoms.

*Spinulate or Pin-shaped Spicules of various Genera.*

Pl. IX. fig. 1. Stout elongate spicule, with evenly rounded head and smooth straight shaft, nearly cylindrical in the upper half, then tapering to an acute point. The axial canal with a slight inflation at the head, continuous throughout the shaft, and opening at the apex. Length 1·06 mm., thickness ·03 mm.

*Suberites* (a).—Pl. IX. fig. 2. Shaft straight, elongate, slender, smooth, and fusiform; head small, conical, constricted at the neck. Length ·425 mm., thickness ·013 mm. Very similar spicules occur in *Suberites senilis*, Ridley and Dendy (Chall. Rep. vol. xx. p. 209, pl. xlv. fig. 1a), from the North Pacific, at a depth of 2050 fathoms.

Pl. IX. fig. 3. Stout, smooth, straight; head rounded, slightly constricted neck, very gradually tapering shaft, acutely pointed. Length 1·21 mm., thickness ·03 mm.

Pl. IX. fig. 4. Spicule straight; head rounded, with prominent spines; shaft gradually tapering, furnished with a few small spines. Length ·305 mm., thickness ·012 mm.

*Cribrella* (a).—Pl. IX. fig. 5. Robust, slightly curved, spinulate; head evenly rounded, bulbous, not distinctly marked off from the shaft, which gradually tapers to an acute point; the head and the upper third of the shaft covered with stout, prominent, conical spines; the rest of the shaft smooth. Length ·35 mm., thickness at summit ·045 mm. A similar, but somewhat smaller, spicule is figured by Mr. Carter in *Cribrella hospitalis*, Osc. Sch. (Ann. & Mag. N. H. s. 4, vol. xviii. 1876, pl. xv. fig. 36a).

Pl. IX. figs. 6, 7, 8. Pin-shaped spicules, with straight smooth shafts; heads evenly rounded, constriction at neck, tapering in the lower half, acutely pointed. Length ·5 to ·7 mm., thickness ·02 to ·036 mm. Similar spicules are present in *Spirastrella transitoria*, Ridley ('Alert' Rep. p. 623, pl. liv. fig. q), from Darros Island, at a depth of 22 fathoms.

Pl. IX. figs. 9, 10, 11. Smooth, slender, curved spicules, with prominent evenly rounded heads, and shafts of the same thickness for the upper two-thirds, below this tapering to an acute point. Length ·18 to ·4 mm., thickness ·005 to ·01 mm.

Pl. IX. fig. 12. Spinulate, with well-marked rounded head; straight, fusiform, smooth shaft, acutely pointed. Length  $\cdot 15$  mm., thickness  $\cdot 013$  mm. Similar spinulates occur in *Proteleia Sollasi*, Ridley and Dendy (Chall. Rep. vol. xx. p. 214, pl. xlii. figs. 8e, 8f), from Simon's Bay at a depth of 10–20 fathoms.

Pl. IX. fig. 19. Small, slender spinulate, the upper portion curved; shaft slightly fusiform, smooth. Length  $\cdot 115$  mm., thickness  $\cdot 006$  mm.

Pl. IX. fig. 14. Approximately straight, smooth; head evenly round, not constricted; shaft gradually tapering to an acute point. Axial canal shown as a very delicate even thread, not inflated at the head. Length  $\cdot 513$  mm., greatest thickness  $\cdot 045$  mm.

Pl. IX. figs. 15–18. Straight nail-like spinulates, with rounded well-defined heads, which are either covered with blunted spines or tubercles or quite smooth; the shafts taper from the head and are spined throughout; the spines in the upper portion projecting at right angles, whilst lower down the shaft they are oblique, pointing to the head of the spicule. Length  $\cdot 085$  to  $\cdot 175$  mm., thickness of shafts  $\cdot 005$  to  $\cdot 02$  mm. Spined spinulates resembling these are figured by Bowerbank in the recent *Hymenraphia clavata* and in *H. simplex* (Mon. Brit. Spong. vol. iii. pl. xxvi. fig. 9, pl. lxxx. fig. 3); and Dr. Rüst figures a similar form from the Jurassic strata of Ilsede, Hanover (Palæontographica, Bd. 31, pl. xx. fig. 5).

Pl. VIII. figs. 37, 37a, 38. Spicules straight, nail-like in form; heads rounded or flattened, with very prominent spines, projecting horizontally or recurved, sometimes with a verticillate arrangement; shafts gradually tapering to an acute point, provided with minute spines directed upwards towards the head of the spicule. Length  $\cdot 073$  to  $\cdot 116$  mm., thickness  $\cdot 006$  to  $\cdot 01$  mm. Somewhat similar spinulates are figured by Bowerbank in *Hymenraphia coronula* (Mon. Brit. Spong. vol. iii. p. 246, pl. lxxix. figs. 3, 4). A form similar to 37a is figured by Osc. Schmidt in *Stelletta pumex* (Adriat. Spong. Suppl. i. p. 32, pl. iii. fig. 9a); but that it really belongs to a species of *Stelletta* is very doubtful.

#### *Abnormal Spinulate.*

Pl. VIII. fig. 29. Spicule with subcylindrical curved shaft, at the head of which several prominent rounded tubercles are grouped. The axial canal has a small bulbous inflation at the

summit. Of this form, only the upper portion of a spicule is known. The shaft is  $\cdot 045$  mm. in thickness.

Spinulate or pin-shaped spicules, though very abundant, are relatively less numerous in the Oamaru material than the acuate and acerate forms. They vary considerably in size; small forms not exceeding  $\cdot 1$  mm. in length by  $\cdot 01$  mm. in thickness, whilst the larger reach to  $1\cdot 21$  mm. by  $\cdot 045$  mm. They correspond very fairly with the spinulate spicules in recent sponges of the *Clavulina* group belonging to the following genera: *Suberites*, *Polymastia*, *Cliona*, and *Spiraстрrella*. Similar spicules are also present in *Esperella* and *Axinella*. That some of the fossil spinulates most probably belonged to *Spiraстрrella* is shown by the occurrence of the characteristic spiral flesh-spicules of this genus in the deposit. As detached, in dredgings by H.M.S. 'Egeria' off the S.W. of Australia, they are present at depths of 2479 fathoms.

*Grapnel Spicule of Acarnus, Gray.*

Pl. IX. fig. 13. Spicule with evenly rounded head and straight subcylindrical shaft, which terminates abruptly in a slight inflation, from which five or six rays with recurved ends extend in a generally horizontal direction. The axial canal has a slight bulbous expansion in the head, thence it extends as a delicate thread to the opposite end, where it is slightly enlarged, and apparently sends out branches into the rays. The length of the spicule is  $\cdot 21$  mm. by  $\cdot 015$  mm. in thickness. Spicules nearly corresponding in form and size occur in the recent *Acarnus Wolffgangi*, Keller (Zeit. f. wiss. Zool., Bd. 48, 1889, p. 399, t. xxv. f. 56), from the Red Sea. The larger skeletal spicules of this genus are acuates and tibiellas, similar to those which have been already referred to. A detached grapnel spicule of *Acarnus* with three simple rays is present in a dredging off the S.W. coast of Australia at a depth of 2479 fathoms.

*Forceps or Hair-pin Flesh-Spicules of Forcepia, Carter.*

*Forcepia Carteri*, n. sp.—Pl. IX. figs. 20, 21. Spicule curved, resembling a hair-pin, the arms subcylindrical, thickest at the curve; at their ends they are slightly divergent, and one is a little longer than the other; each arm terminates with a convex slightly expanded cap or bulb. The surface covered with very minute spines; those on the arms are recurved in the direction

of the curve of the spicule. Length .036 mm., thickness of arms .0053 mm., distance between the ends .108 mm. This rare form is clearly allied to the flesh-spicules of *Forcepia*, Carter (Ann. & Mag. N. H. s. 4, vol. xiv. 1874, p. 248, pl. xv. fig. 47), originally based on detached fossil spicules from Panama, and subsequently on recent sponges, which, in addition to the flesh-spicule, possess acuate and tibiella skeletal spicules, and in some cases minute anchorates and hooks as well. The Oamaru spicule (fig. 20) is closest allied to the forceps in *Forcepia* (*Halichondria*) *bulbosa*, Carter, sp. (Ann. & Mag. N. H. s. 4, vol. xviii. p. 312, pl. xiii. figs. 19 *e*, *f*, *g*); but it differs in the curvature and divergence of the arms, and may be accepted as indicating a new species, which may be termed *Forcepia Carteri*. According to Vosmaer's figures, the forceps spicules in the recent *F. bulbosa* vary considerably in details (Bronn's Klass. u. Ordn. des Thierreichs, Porifera, Taf. xvi. fig. 37, Taf. xxi. figs. 5, 6). One recent species, *F. colonensis*, Carter, with comparatively large forceps, is found at Port Phillip Heads, Australia. It is worthy of note that in a spicule so minute as the one figured on the scale of 600 diameters there is a close correspondence with the spicules of existing forms in such small details as the unequal length of the arms and the downward direction of the surface spines. In another spicule, probably referable to the same sponge (Pl. IX. fig. 21), the arms diverge so as to form an open curve, and they have a small convex cap on their ends.

*Forcepia Vosmaeri*, n. sp.—Pl. IX. fig. 22. Forceps spicule, the arms nearly straight, tapering, thickest at the curve, subparallel with each other, slightly unequal in length, abruptly truncate, and divergent near their apices. The surface thickly covered with minute spines projecting directly outwards. A continuous axial canal extends throughout the spicule. Length .068 mm., greatest thickness at curve .0087 mm. This differs considerably from the preceding forms, and from the forceps of other recent sponges. It probably belongs to a distinct species, which may be known as *Forcepia Vosmaeri*.

*Bow-shaped or Tricurvate Flesh-Spicules of*  
*Amphilectus, Vosmaer.*

Pl. IX. fig. 23. Smooth, slender, tricurvate, nearly evenly cylindrical, with subangular central bend. Length, from end to end, .21 mm., thickness .005 mm. Similar but larger spicules



are present in *Amphilectus pilosus*, Ridley and Dendy (Chall. Rep. vol. xx. p. 126, pl. xix. fig. 5 b), from Kerguelen at depths of 50 to 70 fathoms.

Pl. IX. fig. 24. Tricurved, smooth, with open central curve, extremities pointed. Length .096 mm., thickness .006 mm. A similar but slightly longer spicule is figured by Ridley in *Amphilectus tibiellifer* ('Alert' Rep. p. 428, pl. xlii. fig. t), from Torres Straits.

Tricurved spicules are of rare occurrence in the Oamaru material. Though the forms described are referred to *Amphilectus*, the same kind of flesh-spicule is common to *Desmacidon*, *Esperella*, *Hamacantha*, and other genera of recent sponges.

*Hook-shaped or Bihamate Flesh-Spicules of Esperella, Vosmaer, and other Genera.*

Pl. IX. fig. 25. Spicule slender, C-shaped, nearly of an even thickness throughout, regularly curved. Height .076 mm., thickness .003 mm.

Pl. IX. fig. 26. Small, slender, abruptly curved in the centre, ends acute, sharply bent inwards. Height .05 mm., thickness .003 mm.

Pl. IX. fig. 27. Spicule C-shaped, very evenly rounded. Height .13 mm., thickness .006 mm. This form resembles the hook-spicules of *Gellius glacialis*, Ridley and Dendy (Chall. Rep. vol. xx. p. 41, pl. xiii. figs. 12, 15), from the Agulhas Bank at a depth of 150 fathoms.

Pl. IX. fig. 28. Spicule stout, very openly curved, partly contort, ends acute, curved inwards. Height .205 mm., thickness .01 mm.

Pl. IX. fig. 29. Spicule small, evenly curved, ends very acute. Height .06 mm., thickness .003 mm.

Pl. IX. fig. 30. Stout spicule, C-shaped, ends contort, sharply bent inwards. The axial canal distinctly shown, traversing the specimen and opening at the ends. Height .185 mm., thickness .011 mm. Similar but somewhat larger spicules are present in *Cladorhiza moruliformis*, Ridley and Dendy (Chall. Rep. vol. xx. p. 90, pl. xxi. fig. 15), from the Southern Ocean, south-west of Australia, at a depth of 1950 fathoms.

Pl. IX. fig. 31. Small hook-shaped, ends contort, abruptly bent, acutely pointed. Height .043 mm., thickness .0026 mm.

Pl. IX. fig. 32. Stout hook-shaped, ends evenly but narrowly

rounded. Axial canal continuous through the spicule and opening at both ends. Height .46 mm., thickness .018 mm.

Bihamate spicules of the same character as those referred to above are more especially present in the following genera of recent sponges: *Esperella*, *Amphilectus*, *Myxilla*, *Forcepia*, and *Cladorhiza*. Bihamate spicules are known as fossil from the Lower Lias upwards; but, as rule, those which have hitherto been recognized from the Cretaceous and lower rocks are considerably larger than those from Oamaru and in recent sponges.

*Clasp-hook or Trenchant Bihamate Flesh-Spicules of*  
*Hamacantha, Gray.*

*Hamacantha Johnsoni*?, Bowk., sp.—Pl. IX. fig. 33. Spicule robust, smooth; shaft nearly straight or with a slight curve, the inner edge with a faintly-marked shallow curve. Ends contort, barbed, with distinct circular notch at the bend. Axial canal continuous throughout the spicule, and opening at the ends of both the hooks. Height .15 mm., greatest thickness of shaft, including edge, .02 mm. A similar but smaller spicule is represented in fig. 37.

Another form (Pl. IX. fig. 34) is nearly similar to the preceding (fig. 33), but with a well-marked open notch or curve in the central portion of the inner edge of the shaft. Axial canal shown, but it is much finer than in the preceding. The barbed ends may be either symmetrical or contort in various degrees, just as in recent spicules of the same kind. These spicules (figs. 33, 34) are strikingly similar in form and size to those of the recent *Hamacantha* (*Hymedesmia*) *Johnsoni*, Bowk., sp. (Mon. Brit. Spong. vol. i. p. 247, pl. v. fig. 112), from Madeira, and in the same species from near the Faroe Islands, as figured by Mr. Carter (Ann. & Mag. N. H. s. 5, vol. ix. 1882, p. 296, pl. xi. fig. 21 c, d). They correspond equally closely with those in *Vomerula esperoides*, Ridley and Dendy (Chall. Rep. vol. xx. p. 60, pl. xvii. fig. 2a, b), from the Agulhas Bank and off the Rio de la Plata; and these again, according to the same authors, are similar to the spicules in *Hamacantha papillata*, Vosm. (Spong. Willem Barent's Exp. p. 28). It may be doubted if there are sufficient grounds for separating *Vomerula*, Osc. Sch., from *Hamacantha*, Gray. In addition to the distinctive flesh-spicules, there are in the Oamaru material the corresponding acerate and

acuate skeletal spicules of *Hamacantha*; so that it is safe to conclude that sponges of this genus were present.

*Hamacantha Huttoni*, n. sp.—Pl. IX. fig. 35. Robust bihamate, having a curved shaft with wide laminar inner margin; rounded above and below; hooks barbed, projecting outwards so as to leave open oval notches beneath the curves at both ends. A well-marked axial canal is continuous throughout the spicule, and opens at the extremity of the hooks. Height .22 mm., greatest width of shaft .027 mm. This spicule probably belongs to a new species, which may be termed *Hamacantha Huttoni*, after Capt. F. W. Hutton, F.G.S., to whom we are indebted for first sending over the Oamaru material to this country.

*Hamacantha*?, sp.—Pl. IX. fig. 36. Robust bihamate; shaft slightly curved, cylindrical, either without an inner laminated flange, or having a slightly developed edge near both ends, which are evenly rounded without a distinct notch; extremities acute, with flanges and barbs directed outwards. Height .205 mm., thickness of shaft .012 mm. This form is intermediate in character between the ordinary C-shaped bihamates, such as that figured, Pl. IX. fig. 32, and the normal bihamates of *Hamacantha*, Pl. IX. fig. 34; the flanges and notches of the shaft in this latter are not developed, whilst the hamate ends are similar. Bihamates in which the *Hamacantha* characters are still less developed than in this fossil occur in *Esperella Simonis*, Ridley and Dendy (Chall. Rep. vol. xx. p. 73, pl. xv. fig. 13), from Simon's Bay, 15–20 fathoms.

#### *Flesh-Spicules of Melonanchora, Carter.*

*Melonanchora* (a).—Pl. IX. fig. 39. Equianchorate with smooth evenly-curved shaft and unusually long, slender, curved teeth, which are bent over so that those of the opposite ends are nearly in contact or overlap each other. Falces very prominent. Length of spicule .066 mm., of the teeth .034 mm., thickness of shaft .007 mm. Only a lateral view of this spicule has been recognized, but it accords so materially with the same aspect of the larger anchorates in *Melonanchora elliptica*, Carter (Ann. & Mag. N. H. s. 4, vol. xiv. 1874, p. 212, pl. xiii. fig. 11), the type of the genus, that there is little doubt of the relationship. In size also the fossil corresponds closely with the recent spicule, but the teeth in this latter, judging from the figures, are less developed. Osc. Schmidt has already pointed out that this form

cannot be considered as the young or immature stage of the melon-shaped spicule of the same species as supposed by Mr. Carter (Spong. Mexico, p. 85).

*Melonanchora Morlandi*, n. sp.—Pl. IX. fig. 38. Spicule oval or melon-shaped in outline; ends narrowly rounded, sides evenly curved, and of about an even width, a regular well-marked sub-circular inner notch at both ends, but none in the centre. Outer margins smooth and even, the laminæ gradually thinning to a knife-like edge; a definite axial canal extending quite round the spicule just within the margin. Traces of transverse striæ across the walls. Length of spicule .13 mm., width .08 mm. Thickness or width of the wall .018 mm.

The character of this spicule may be understood if we suppose the shafts only of two of the ordinary bihamate spicules of *Hamacantha*, like those represented on Pl. IX. fig. 33, placed *vis-à-vis*, and welded into a single spicule, which would then have the same outline, the same circular notch at the ends, and the same knife-edge at the inner margin as the present fossil; further, if the canals in the *Hamacantha* spicules were connected together they would also resemble the continuous axial canal of the melon-spicule. As compared with the melon-shaped spicule of the recent *Melonanchora elliptica*, Carter (Ann. & Mag. N. H. s. 4, vol. xiv. 1874, p. 212, pl. xiii. figs. 6–12, pl. xv. figs. 35 *a*, *b*), the present fossil has the remarkable peculiarity that it only includes one-half the recent form, for whilst the recent spicule consists of two oval frames at right angles to each other, the fossil possesses only one, and yet it has every appearance of being complete. Beyond that the fossil is larger than the recent “melon” spicule and has not the notch in the middle of the inner margin, there is considerable similarity to the recent form. It indicates a new species of the genus, which may be termed *Melonanchora Morlandi*, in honour of Mr. H. Morland, to whom we are indebted for the discovery of this spicule in the Oamaru material. The skeletal spicules of the recent type species of *Melonanchora* are, according to Mr. Carter, simple acuates and tibiellas, of similar proportions to some of those in the Oamaru material figured on Pls. VIII. and IX. The recent species is only known from the North Atlantic and from the Caribbean Sea (Spong. Mexico, p. 85, t. ix. fig. 8).

*Anchorate Flesh-Spicules of Myxilla, Desmacidon, and allied Genera.*

*Myxilla* ? (a).—Pl. IX. figs. 41–44. Equianchorate spicules with strongly curved shafts, and elongate, acutely-pointed teeth. Average length of spicule  $\cdot 071$  mm., of the teeth  $\cdot 017$  ; thickness of shaft  $\cdot 01$  mm.

*Myxilla* (b).—Pl. IX. fig. 48. Equianchorate with relatively short, thick, curved shaft, and three simple teeth at each end. Length of spicule  $\cdot 026$  mm., of teeth  $\cdot 0083$  mm., width across teeth  $\cdot 013$  mm., thickness of shaft  $\cdot 007$  mm. This form is of the same character as that shown in fig. 40, but the shaft is not inflated. Somewhat similar anchorates are present in *Myxilla compressa*, Ridley and Dendy (Chall. Rep. vol. xx. p. 139, pl. xxvii. fig. 9.d), from off the mouth of the Rio de la Plata, 600 fathoms.

Pl. IX. figs. 49, 50. Spicules with strongly curved, stout shaft and prominent curved teeth ; the lateral teeth at either end of the spicule are extended so as to form claw-shaped processes. In size the spicules correspond with the preceding (fig. 48).

Pl. IX. fig. 53. Equianchorate spicule with strongly curved shaft and short stout blunt teeth, which openly diverge from the shaft. Length of spicule  $\cdot 031$  mm., of teeth  $\cdot 012$  mm., thickness of shaft  $\cdot 0053$  mm. This spicule is of the same type as the foregoing (figs. 48, 49, 50), but it is larger, and further distinguished by the blunted character of the teeth and their open disposition.

*Myxilla* (c).—Pl. IX. fig. 45. Equianchorate with stout even shaft, ends triangular, the lateral teeth nearly straight, margins infolded, with prolonged incurved, hook-like extremities. Anterior teeth narrow, elongate. Length of spicule  $\cdot 037$  mm., of lateral teeth  $\cdot 013$  mm., thickness of shaft  $\cdot 017$  mm. Similar spicules are present in *Myxilla arborescens*, Ridley ('Alert' Rep. p. 430, pl. xlii. fig. a''), from shallow water at Port Jackson, but their shafts are less robust and the lateral teeth obtuse.

*Myxilla* (d).—Pl. IX. fig. 46, Pl. X. figs. 46, 47. Equianchorates with robust shaft and regularly curved simple teeth. Length of spicule  $\cdot 031$  mm., of the teeth  $\cdot 011$  mm., width across teeth  $\cdot 016$  mm., thickness of shaft  $\cdot 005$  mm. ; Pl. X. fig. 47 is a lateral view of probably the same spicule. These spicules

correspond with the equianchorates of *Myxilla nobilis*, Ridley and Dendy (Chall. Rep. vol. xx. p. 140, pl. xxvii. figs. 15 *c, d*), from off the Crozet Islands, at depths from 240–550 fathoms.

Pl. IX. figs. 47, 47 *a*. Small equianchorates, shafts curved, teeth short, simple. Fig. 47 is a front view; 47 *a* is a lateral view of a similar but larger form. Length of spicule (fig. 47) .016 mm., width across teeth .0067 mm., thickness of shaft .0016 mm.

Pl. IX. figs. 51, 52. Small equianchorates with stout curved shafts, ends rounded, and short, simple teeth. Length of spicule .036 mm., width across teeth .02 mm., thickness of shaft .006 mm. Fig. 52 is a lateral view of probably the same spicule.

Pl. IX. figs. 54, 55. Equianchorates with stout shafts, rounded ends, and simple slightly extended teeth. Length (fig. 54) .046 mm., width across teeth .016 mm., thickness of shaft .006 mm.

*Myxilla* (e).—Pl. X. fig. 21. Equianchorate with strongly curved shaft, and having the lateral teeth much extended and curved inwards, so that they nearly meet each other. Anterior tubercle elongate. Length of spicule .04 mm., of lateral teeth .017 mm., width across teeth .016 mm., thickness of shaft .0033 mm.

*Myxilla* (f).—Pl. X. fig. 22. Lateral view of equianchorate with an evenly curved shaft and short incurved obtuse teeth. Length of spicule .027 mm., of teeth .006 mm., thickness of shaft .005 mm. Detached spicules of this form are present in the 'Egeria' dredgings off the S.W. coast of Australia, at a depth of 3000 fathoms.

*Myxilla* (g).—Pl. X. fig. 30. Equianchorate with slightly curved shaft and long slender upright teeth. Length of spicule .051 mm., of teeth .02 mm., thickness of shaft .005 mm. Only the lateral view known.

*Myxilla* (h).—Pl. X. fig. 48. Equianchorate with sharp harpoon-like ends; the lateral teeth triangular, acutely pointed, anterior teeth outwardly projecting. Length of spicule .037 mm., of teeth .014 mm., width across teeth .015 mm., thickness of shaft .007 mm. This spicule is distinguished by the angular ends and the long slender teeth. Somewhat similar but smaller equianchorates are present in *Myxilla veneta*, Osc. Sch. (Adriat. Spong. p. 71, pl. vii. fig. 4 *c*).

*Myxilla Dendyi*, n. sp.—Pl. X. figs. 49–52. Anchorate spicules

with stout curved shaft having three palms or teeth at the upper end; the lateral ones widely extended and curved, horn-like, the central tooth projecting prominently forwards and downwards. The opposite end of the spicule is subtriangular, the lateral palms with revert margins inwardly curved above, and a prominent elongate tubercle with rounded ends. Length of spicule  $\cdot 037$  mm., width across upper palms  $\cdot 025$  mm., length of lower palms  $\cdot 025$  mm., thickness of shaft  $\cdot 01$  mm. Fig. 49 is a front view, and figs. 50, 51 lateral views of the same form of spicule. Fig. 52 is a much smaller form which may be only a young stage of the larger spicules. In a front view of this, the central tubercle (?) of the upper end projects as a circular or slightly elliptical process, and beneath it is an elongate spatulate tooth or palm; the tubercle of the lower end of the spicule is subtriangular in outline. The length of this spicule is  $\cdot 02$  mm., width across the teeth  $\cdot 014$  mm.

The only recent spicules with which these forms can be compared are some peculiar anchorates described by Osc. Schmidt in *Sceptrella regalis*, from off Florida (Atlant. Spong. p. 58, pl. v. fig. 24 c). In these the larger end of the spicule is proportionately less widely extended than in our fossils, but the anterior palm has a similarly projecting tongue-shaped process. According to Osc. Schmidt, these anchorates are associated with "sceptrella" spicules; but Mr. H. J. Carter, and subsequently Ridley and Dendy, consider that this association of such different forms in one sponge arises from a mistake, and that the anchorates really belong to a species of *Myxilla* (Ann. & Mag. N. H. s. 5, vol. iii. 1879, p. 359; Chall. Rep. vol. xx. p. lxii, note). In accordance with this view, the present fossil spicules may be referred to *Myxilla*, and as they indicate a new species, it may be termed *Myxilla Dendyi*.

*Desmacidon* (a).—Pl. IX. fig. 40. Short stout equianchorate, the central portion of the shaft inflated, with neck-like constrictions above and below; teeth curved, stout, bent inwards, anterior prominent. Length of spicule  $\cdot 028$  mm., of teeth  $\cdot 01$  mm., greatest width of shaft  $\cdot 01$  mm. The anchorates in *Desmacidon tunicata*, Os. Sch. (Atlant. Spong. p. 55, pl. v. fig. 21 b), are approximately similar to this form, but their shafts are not inflated.

*Desmacidon* (b).—Pl. X. fig. 36. Equianchorate with curved shaft, slightly constricted in the middle and at both ends; lateral

teeth or palms stout, evenly curved, anterior tubercles ovate, prominent tongue-shaped anterior palms. Length of spicule  $\cdot 073$  mm., of teeth or palms  $\cdot 023$  mm., width across them  $\cdot 03$  mm., greatest thickness of shaft  $\cdot 015$  mm. This form resembles the anchorates in an Australian variety of *Desmacidon fruticosa*, Montagu, sp., figured by Ridley and Dendy (Chall. Rep. vol. xx. p. 104, pl. xxiii. figs. 10 *b*, *c*), but it is about twice as large. It corresponds also with Mr. Carter's figures of the equianchorate of *Halichondria incrustans*, Bow. (Ann. & Mag. N. H. s. 4, vol. xiv. 1874, p. 208, pl. xiii. figs. 1 *a*, *b*, *c*). The lateral view of probably a similar spicule is shown in fig. 41.

*Desmacidon* (c).—Pl. X. figs. 38, 39. Equianchorate with curved shaft, lateral teeth somewhat incurved and extended below into a claw-like process; anterior tubercles elongate, anterior palm tongue-shaped. Length of spicule  $\cdot 05$  mm., of teeth  $\cdot 019$  mm., width across teeth  $\cdot 26$  mm., thickness of shaft  $\cdot 006$  mm. Fig. 38 is the front, and fig. 39 the lateral view of the same spicule.

*Halichondria* (a).—Pl. X. fig. 40. Equianchorate with strongly curved shaft, so that, viewed laterally, it is G-shaped; teeth incurved, obtuse, central lamina very prominent. Length of spicule  $\cdot 046$  mm., of teeth  $\cdot 016$  mm., thickness of shaft  $\cdot 0067$  mm. The lateral aspect of this spicule resembles that of the equianchorates of *Halichondria pustulosa*, Carter (Ann. & Mag. N. H. s. 5, vol. ix. 1882, p. 286, pl. xi. fig. 1 *f*), from near the Falkland Islands at depths of 50–70 fathoms.

*Halichondria* (b).—Pl. X. fig. 42. Equianchorate with strongly curved and apparently somewhat contort shaft; teeth elongate, inwardly curved and acutely pointed, anterior falcies very prominent. Length of spicule  $\cdot 034$  mm., of teeth  $\cdot 015$  mm., thickness of shaft  $\cdot 0041$  mm. Only a lateral view of this spicule is known. It is of the same character as the preceding (fig. 40), but smaller, and the teeth are proportionately longer, so that they overlap each other in the middle of the spicule.

Pl. X. fig. 43. Equianchorate with unusually long curved shaft and short obtuse teeth. Only the lateral aspect known. Length of spicule  $\cdot 038$  mm., of teeth  $\cdot 0042$  mm., thickness of shaft  $\cdot 0033$  mm.

It will be seen from the foregoing descriptions that the anchorate flesh-spicules of the types of those occurring in *Myxilla* and *Desmacidon* are very abundant and varied in the Oamaru



material, and making due allowance for the possibility that in some species more than one form of anchorate may be present, it seems probable that at least twelve species of one or other of these genera are represented.

*Palmate Inequianchorate Flesh-Spicules of Esperella, Vosmaer*  
(= *Esperia*, *Nardo*).

*Esperella* (a).—Pl. X. figs. 1, 2. Large, robust, inequianchorate with slightly curved shafts, somewhat thicker near the larger end. The lateral palms curved and extended inferiorly to an acute point, directed inwards, outer margins strongly reverted; anterior palm tongue-shaped, the broad end slightly projecting above the general curve of the head, tubercle pear-shaped. Smaller end of the spicule narrow, the lateral palms with revert margins, tubercle nearly oval. Length of spicule .175 mm., of anterior palm .075 mm., width of larger end .085 mm., of smaller .06 mm., greatest thickness of shaft .035 mm. The axial canal is well shown traversing the shaft from the lower to the upper tubercle. In general form this spicule closely resembles the large inequianchorates of *Esperia diaphana*, Osc. Sch. (Atlant. Spong. p. 57, t. iv. fig. 13), but if Schmidt's measurements of these are correct, the Oamaru forms are considerably smaller.

*Esperella* (b).—Pl. X. fig. 3. Inequianchorate with large upper end, the lateral palms evenly curved, rounded inferiorly and not extended, the margins reverted, anterior palm elliptical, tubercle elongate pear-shaped; the lower end of the spicule subquadrate, anterior palm extending nearly the whole width, tubercle subtriangular. Length of spicule .086 mm., of larger end .051 mm., width of same .04 mm., length of anterior palm .043 mm., length of smaller end of spicule .013, width .023, thickness of shaft .006 mm. This form corresponds with the large inequianchorates in *Esperia anceps*, *E. syrinx*, and *E. Lorenzii*, figured by Osc. Schmidt (Adriat. Spong. p. 56, pl. v. figs. 5 a, b, 6 a, b, 7 a, b), but the recent forms are somewhat larger, and their larger ends proportionately smaller than in this fossil.

*Esperella* (c).—Pl. X. fig. 4. Inequianchorate with large semi-elliptical upper end, having the lateral palms very evenly curved, the margins reverted, and the lower angles slightly projecting; anterior palm tongue-shaped, produced below the level

of the laterals, tubercle distinct, diamond-shaped. Smaller end of spicule semi-elliptical, lateral palms with faintly marked margins; tubercle wedge-shaped, with small processes on either side terminated by tubercles; shaft slender. Length of spicule  $\cdot 07$  mm., of larger end  $\cdot 043$  mm., width of same  $\cdot 034$  mm.; length of anterior palm  $\cdot 051$  mm., width  $\cdot 017$  mm. Smaller end, length  $\cdot 013$  mm., width  $\cdot 019$  mm., thickness of shaft  $\cdot 003$  mm. Axial canal clearly shown.

*Esperella* (d).—Pl. X. fig. 5. Inequianchorate, large end rounded, lateral palms evenly curved, not prolonged below, anterior tubercle large, pear-shaped; small end of spicule oblong, lateral margins strongly reverted, central tubercle large, ovate. Shaft stout. Length of spicule  $\cdot 066$  mm., of larger end  $\cdot 035$  mm., width the same; length of smaller end of spicule  $\cdot 012$  mm., width  $\cdot 02$  mm.; thickness of shaft  $\cdot 006$  mm. The axial canal extends through the shaft from one tubercle to the other.

*Esperella* (e).—Pl. X. fig. 6. Inequianchorate with semi-elliptical larger end, the margins of the lateral palms evenly curved and revert, tubercle large, pear-shaped, anterior palm shorter than the lateral; smaller end of spicule subquadrate, central tubercle ovate, prominent, extending below the level of the base; shaft robust. Length of spicule  $\cdot 043$  mm., of larger end  $\cdot 023$  mm., length of smaller end  $\cdot 006$  mm., width  $\cdot 016$  mm., thickness of shaft  $\cdot 0083$  mm.

*Esperella* (f).—Pl. X. fig. 11. Inequianchorate with the large end semi-elliptical, rounded above, lateral palms curved above, sides nearly straight, tubercle distinct, pear-shaped, anterior palm tongue-shaped. Smaller end of spicule subquadrate, with nearly straight base, margins slightly revert, tubercle elongate, anterior palm with curved upper margin extending across the end. Length of spicule  $\cdot 06$  mm., of larger end  $\cdot 036$  mm., width  $\cdot 027$  mm. Length of smaller end  $\cdot 01$  mm., width  $\cdot 015$  mm., thickness of shaft  $\cdot 005$  mm. Axial canal distinctly shown. This form resembles the large inequianchorate in *Esperella Simonis*, Ridley and Dendy (Chall. Rep. vol. xx. p. 73, pl. xv. fig. 16), from Simon's Bay, at depths of 10–20 fathoms.

*Esperella* (g).—Pl. X. fig. 12. Inequianchorate with the larger end semi-elliptical in outline, lateral palms evenly curved, margins revert, rounded inferiorly, tubercle diamond-shaped, distinct; anterior palm short, but doubtful if it is complete. Small end of spicule with slightly curved base, narrower below,

tubercle conical, slightly projecting below the base. Axial canal extending from the upper to the lower tubercle. Length of spicule  $\cdot 076$  mm., of large end  $\cdot 046$  mm., width of same  $\cdot 038$  mm. Length of small end of spicule  $\cdot 012$  mm., width  $\cdot 02$  mm. Shaft  $\cdot 006$  mm. thick.

*Esperella* (h).—Pl. X. fig. 13. Inequianchorate, large end semi-elliptical; large prominent pear-shaped tubercle, the upper end projecting beyond the summit. Small end of spicule sub-oblong; prominent ovate tubercle, base nearly straight. Length of spicule  $\cdot 076$  mm., of large end  $\cdot 04$  mm., width  $\cdot 36$  mm. Length of small end  $\cdot 013$  mm., width  $\cdot 023$  mm. Thickness of shaft  $\cdot 013$  mm. This form differs from the preceding in the thicker shaft and larger tubercles at the upper end. It corresponds in form with the large inequianchorate figured by Ridley in *Esperia gelatinosa* ('Alert' Rep. p. 611, pl. liv. fig. *f*'), from near Providence Island, Mascarene Group.

*Esperella* (i).—Pl. X. fig. 14. Inequianchorate with semi-ovate larger end, the lateral palms with evenly curved revert margins, projecting slightly below and arched inferiorly. Tubercle large, pear-shaped, anterior palm tongue-shaped. Small end of spicule evenly rounded, central tubercle triangular; anterior palm extending across base, upper margin convex. Length of spicule  $\cdot 086$  mm., of larger end  $\cdot 053$  mm., width  $\cdot 04$  mm. Length of small end  $\cdot 016$  mm., width  $\cdot 023$  mm., thickness of shaft  $\cdot 0067$  mm.

*Esperella* (k).—Pl. X. fig. 15. Inequianchorate with large end subtriangular in outline; lateral palms, margins curved, slightly prolonged inferiorly; lower end with rounded base. Length of spicule  $\cdot 08$  mm., of larger end  $\cdot 036$ , length of smaller end  $\cdot 01$ , width  $\cdot 02$ . Only the lateral view of this spicule is known.

The foregoing spicules (Pl. X. figs. 3-6, 11-15) all exhibit the same general characters as the large inequianchorates in recent species of *Esperella*, and they differ from these and from each other only in minor details. It is probable that each form represents a distinct species.

*Esperella* (l).—Pl. X. fig. 7. Small inequianchorate with strongly curved shaft, the larger end with evenly rounded lateral palms and very prominent anterior tubercle. Small end of spicule subquadrate in outline, with an ovate subcentral tubercle. Length of spicule  $\cdot 034$  mm., of large end  $\cdot 022$  mm., width

·023 mm., length of small end ·01; thickness of shaft ·003 mm. Only an oblique view of this form is known.

*Esperella* (m).—Pl. X. fig. 8. Inequianchorate with large end triangular in outline, tubercle distinct, narrow, elongate; anterior palm short, truncate, not extending below the tubercle. Small end rounded, central tubercle ovate. Length of spicule ·048 mm., of large end ·028 mm., width ·02 mm. Length of small end ·012 mm., thickness of shaft ·0066 mm.

Pl. X. figs. 9, 10. Lateral views of inequianchorates very similar to the preceding (fig. 8).

*Esperella* (n).—Pl. X. fig. 16. Inequianchorate with large end semi-ovate in outline, lateral palms evenly curved, rounded inferiorly, tubercle elongate, anterior palm prominent, rounded; small end of spicule subangular, lateral margins oblique, widest above; tubercle elongate. Axial canal extending from upper to lower tubercle. Length of spicule ·036 mm., of large end ·021 mm., width of same ·022 mm. Length of small end ·011 mm., thickness of shaft ·0045 mm. Similar but slightly larger spicules occur in *Esperella porosa*, Ridley and Dendy (Chall. Rep. vol. xx. p. 70, pl. xv. fig. 17), from Port Jackson, at depths from 30 to 35 fathoms.

*Esperella* (o).—Pl. X. fig. 17. Inequianchorate with nearly ovate large end; lateral palms evenly curved with rounded bases, tubercle diamond-shaped, anterior palm extending the full length of the head. Small end of spicule semicircular; tubercle ovate, distinct. Axial canal connecting the tubercles. Length of spicule ·031 mm., of large end ·021 mm., width ·011 mm., length of small end ·0053, thickness of shaft ·0046 mm. Very similar spicules are figured by Mr. Carter in *Esperia serratohamata* (Ann. & Mag. N. H. s. 5, vol. vi. 1880, p. 49, pl. v. fig. 20 d), from the Gulf of Manaar.

*Esperella* (p).—Pl. X. fig. 18. Inequianchorate with curved shaft, large end with lateral curved palms, slightly extended inferiorly, tubercle ovate. Small end with round tubercle and lateral palms appearing as small knobs in the lateral position in which the spicule is figured. Length of spicule ·022 mm., of large end ·015 mm., width ·01 mm. Width of small end ·0075 mm., thickness of shaft ·0025 mm.

*Esperella* (q).—Pl. X. fig. 20. Only the lateral aspect of this inequianchorate is known. The large end has the palms curved and slightly extended inferiorly; the small end viewed

laterally has the form of a simple hook. A similar inequianchorate is figured by Hansen in *Esperia bihamatifera*, Vosmaer (Norw. North Atlant. Exp., Spong. 1876-8, pl. iii. fig. 5).

*Iophon*?—Pl. X. fig. 19. Inequianchorate with large end semi-ovate in outline, lateral palms evenly curved, slightly extended below, base evenly rounded, tubercle elongate ovate, anterior palm elliptical. Small end round at base, with prominent tubercle and two lateral teeth projecting obliquely upwards. Length of spicule .053 mm., of larger end .023 mm., width .026 mm., thickness of shaft .006 mm. In the character of the small end of the spicule this form resembles some of the inequianchorates belonging to *Iophon*, e. g. *I. abnormalis*, Ridley and Dendy (Chall. Rep. vol. xx. p. 122, pl. xvii. figs. 7, 8).

*Equianchorate Flesh-Spicules of Esperiopsis, Carter.*

*Esperiopsis* (a).—Pl. X. fig. 23. Equianchorate elongate, navicular, the ends semi-elliptical, lateral palms evenly curved, rounded below, tubercles ovate, anterior palms the same width as the spicule, bases truncate. Axial canal extending between the tubercles. Length of spicule .053 mm., of the palmate ends .023 mm., width .015 mm., thickness of shaft .0066 mm. This form is very similar to the equianchorates of the recent *Esperiopsis profunda*, Ridley and Dendy (Chall. Rep. vol. xx. p. 83, pl. xix. fig. 1 b), from the Crozet Islands, Southern Ocean, in a diatom ooze at a depth of 1600 fathoms.

*Esperiopsis* (b).—Pl. X. fig. 24. Navicular equianchorate with subtriangular palmate ends, lateral palms with slightly curved margins, bases nearly straight, tubercles distinct, subtriangular, shaft slender, curved. Axial canal connecting the tubercles at either end. Length of spicule .056 mm., of the palmate ends .025 mm., width of same .016 mm., thickness of shaft .003 mm.

*Esperiopsis* (c).—Pl. X. fig. 26. Equianchorate, elliptical in outline, lateral palms evenly curved, margins slightly revert below, tubercles elongate, distinct, anterior palms nearly as wide as the spicule, bases nearly straight. Length of spicule .05 mm., of the palmate ends .02 mm., width .023 mm., thickness of shaft .004 mm.

Pl. X. fig. 25. This is the lateral view of an equianchorate of the same size as the preceding (fig. 26), but having the shaft apparently wider.

*Esperiopsis* (d).—Pl. X. figs. 27, 28, 29. Stout equianchorate, lateral palms curved, margins revert, rounded below, tubercles elongate, anterior palms tongue-shaped. Length of spicule .11 mm., of palms .043 mm., width of same .047 mm., thickness of shaft .014 mm. This is one of the largest equianchorates known. Forms similar, but somewhat smaller, occur in *Esperiopsis pulchella*, Ridley and Dendy (Chall. Rep. vol. xx. p. 85, pl. xix. figs. 9 *a*, *b*), from the south-west of New Guinea, depth 140 fathoms. Figs. 27, 29 represent front views, and fig. 28 is a side view of this form.

From the above descriptions it may be concluded that at least four species of *Esperiopsis* are present in the Oamaru material. The skeletal spicules in the recent species are acuate or styli-form, and very similar corresponding forms are abundant in the fossil deposit.

*Inequianchorate Flesh-Spicule of Cladorhiza, Sars.*

*Cladorhiza Haasti*, n. sp.—Pl. X. fig. 35. Spicule tridentate, one end much larger than the other; at the large end three prominent teeth—the lateral extending obliquely outwards, and the anterior projecting forward; shaft curved, strongly alate, the alæ widest near the upper end, and gradually tapering; at the small extremity the shaft is curved, so that it becomes at right angles to the main portion, and at the end there is a small triangular tubercle from which three compressed teeth are given off, they are subequal and with a small notch at their summits. Length of spicule .043 mm., of the larger end .013 mm., width of large end from apex to apex of lateral teeth .035 mm., greatest width of shaft .02 mm., width across teeth at small end .015 mm. In general form this spicule resembles the flesh-spicules of *Cladorhiza*, Sars, and it probably represents a new species, which may be termed *C. Haasti*, in memory of the late Sir J. v. Haast, to whom we are indebted for a supply of the Oamaru material. This form approaches nearest to the flesh-spicules of *C. tridentata*, Ridley and Dendy (Chall. Rep. vol. xx. p. 95, pl. xxi. figs. 20 *a*, *b*, *c*), but it is little more than half the size, the alæ are more tapering, and the larger tubercle is pointed. The recent species is from diatom ooze, near the Crozet Islands, at a depth of 1600 fathoms.

The recent species of *Cladorhiza* are distinctively deep-water forms, ranging in depth to 3000 fathoms; the species referred to

above are from the Crozet Islands and from the North-east of New Zealand respectively. The skeletal spicules in the existing species are acuates and pin-shaped, and corresponding forms are likewise present in the Oamaru deposit.

*Anchorate Flesh-Spicules of Chondrocladia, Wyp. Thomson.*

*Chondrocladia* (a).—Pl. X. fig. 31. Equianchorate with an elongated curved shaft of nearly equal thickness throughout as seen laterally. There are at least three short, divergent, acutely-pointed teeth at either end. Length of spicule  $\cdot 058$  mm., of teeth  $\cdot 007$  mm., thickness of shaft  $\cdot 0041$  mm. Viewed laterally this form has the same character as the equianchorates in some of the 'Challenger' species of *Chondrocladia*, e. g. *C. crinita*, Ridley and Dendy (Chall. Rep. vol. xx. p. 101, pl. xxi. fig. 17 a), from N. of New Guinea, depth 2000 faths.; but it is considerably smaller than the recent spicules.

*Chondrocladia* (b).—Pl. X. fig. 32. Equianchorate with nearly straight even shaft slightly swollen at the ends, and with three short conical teeth extending from either end nearly at right angles to the shaft. In the small size and simple character of the teeth this form resembles the normal flesh-spicules of recent species of *Chondrocladia*, but it does not approach very closely to any known form. Length of spicule  $\cdot 053$  mm., of the teeth  $\cdot 005$  mm., thickness of shaft  $\cdot 005$  mm. The cast of an apparently allied form is figured by Rüst from the Jurassic strata of Ilse, Hanover (Pal., Bd. xxxi. pl. xx. fig. 10).

*Chondrocladia* (c).—Pl. X. fig. 33. Equianchorate with slender, elongate, curved shaft, slightly alate near the end, and slender acutely-pointed teeth, curved and slightly directed outwards. There are at least three of these teeth at either end. Length of spicule  $\cdot 045$  mm., of teeth  $\cdot 01$  mm., thickness of shaft  $\cdot 0016$  mm. Spicules of similar character but somewhat larger, and with more teeth, are figured by Ridley and Dendy in *Chondrocladia con-crescens*, Osc. Sch. (Chall. Rep. vol. xx. p. 100, pl. xxi. fig. 12), from the North Pacific at a depth of 2900 fathoms.

*Chondrocladia* (d).—Pl. X. fig. 34. Equianchorate(?) with curved shaft, though straight in front view, and with six or seven small curved teeth at the upper end, whilst at the lower only four are shown. Length of spicule  $\cdot 046$  mm., of teeth  $\cdot 0058$  mm., thickness of shaft  $\cdot 0041$  mm.

*Chondrocladia* (e).—Pl. X. fig. 37. Equianchorate (?) with curved shaft, slightly expanded at either end, and constricted in the middle; at each end four stout incurved teeth are shown, with a central falx or tubercle. Two of the teeth at each end are apparently in advance of the others, they are connected together by a siliceous membrane. Traces of other teeth can be seen by focussing, but whether the full number at either end is 5 or 7 is uncertain. Length of spicule .08 mm., of teeth .023 mm., width across teeth .026 mm., thickness of shaft .011 mm. The front aspect of this spicule corresponds closely with that of the equianchorate in *Chondrocladia virgata*, Wyv. Thoms., as figured by Mr. Carter (Ann. & Mag. N. H. s. 4, vol. xiv. 1874, p. 217, pl. xiv. fig. 21 b). Viewed on end the recent spicule has 7 teeth or claws at each end, but in front only four of these are visible. The fossil spicule is larger and the shaft less expanded than in the type forms of the recent species.

*Bipocillate Flesh-Spicule of Iophon, Gray.*

*Iophon hybridus*, n. sp.—Pl. X. fig. 44. Spicule with a short, apparently straight shaft having three subpalmate teeth at one end and a shallow cup-like base at the other. The lateral teeth of the upper end are evenly curved, with slightly revert margins, blunted inferiorly. The anterior tooth projects apparently directly outwards, the tubercle at its base is slightly elevated above the curve of the lateral teeth. The margins of the cup-like end of the spicule are thickened or inverted and elevated at the sides, so as nearly to meet the lateral teeth of the upper end. The shaft has an axial canal which is slightly inflated at the upper end. Length of spicule .023 mm., width across teeth .02 mm., thickness of shaft .004 mm. This spicule is evidently of the same character as the bipocilli spicules of *Iophon*, Gray, as figured by Bowerbank (Mon. Brit. Spong. vol. i. p. 248, pl. v. figs. 123–127) and by Ridley and Dendy (Chall. Rep. vol. xx. pl. xvii. figs. 3, 9), but it shows a nearer relation to the normal anchorate spicule than the bipocilli of recent sponges of this genus. Ridley and Dendy consider the bipocilli as much modified inequianchorate spicules. Recent spicules of this type are much smaller than the present fossil, which clearly belongs to a new species and may be designated *Iophon hybridus*.

The skeletal spicules of *Iophon* are acuates and tibiellas, not



very dissimilar from those of *Melonanchora*, and several recent species of the genus are found in the Australian and South Seas.

*Anchorate Flesh-Spicules of Guitarra, Carter.*

*Guitarra Carteri*, n. sp.—Pl. XI. figs. 1, 2, 3. Spicules of hour-glass form, consisting of two equal subcircular plates in contact with each other. The shaft is not often distinguishable; it is, as shown in fig. 3, straight and of an even thickness. Usually it is so amalgamated with the lateral portions of the circular plates that it cannot be recognized. The plates bounding it represent the lateral palms of the spicule. The central tubercles are circular in outline and prominent; they are connected by the axial canal, which appears as a fine thread between them (fig. 2). The anterior palms are circular plates of a similar form and size to the lateral plates, and as they meet in the central line they cannot be distinguished from these latter when the front of the spicule is exposed to view. The margin of the lateral palms is transversely striated, and the outer surface of the anterior palm has also on both sides a series of fine transverse markings which reach nearly to the centre (fig. 1). Length of spicules from  $\cdot 09$  to  $\cdot 115$  mm., width  $\cdot 05$  mm. These spicules are much larger than those of the only known recent species, and further different in having the anterior palms meeting in the centre. As indicating a new species they may be named *Guitarra Carteri*, in honour of Mr. H. J. Carter, F.R.S.

*Guitarra intermedia*, n. sp.—Pl. XI. figs. 4–7. Spicules of hour-glass form, but having the lateral palms at either end connected by a constricted interspace (fig. 4), the tubercles distinct and connected by the axial canal. The anterior palm is ovoid in form with definite incurved margins; it extends either obliquely to the shaft (fig. 5) or nearly parallel with it, but the palms do not meet as in the preceding form. The outer surface of the lateral palms is minutely spined and the margins are striated. These spicules range in length from  $\cdot 065$  to  $\cdot 115$  mm., and they are about  $\cdot 045$  mm. in width. An apparently young form (fig. 7), which is magnified on the scale of 600 diameters, is only  $\cdot 04$  mm. in length. In fig. 4 the front surface of a spicule is shown in which the anterior palms have been broken away; fig. 5 is an oblique view of another form showing clearly the margins of the palms; fig. 6 is a lateral view in which the front margins of the anterior palms

appear as if hooked; whilst fig. 7 is an oblique view of a small form in which the axial canal of the shaft appears to be supplemented by canals in the anterior palms. These spicules approach nearer to those of the recent species *Guitarra fimbriata*, but the mature forms appear to be distinctly larger, and they may be considered as indicating a new species, *G. intermedia*.

These peculiar forms of anchorate spicule were first discovered by Mr. Carter in a sponge from the depths of the North Atlantic dredged up by the 'Porcupine' Expedition (Ann. & Mag. Nat. Hist. s. 4, vol. xiv. 1874, p. 210, pl. xiii. figs. 2-5, pl. xv. fig. 34), and they were subsequently found by Osc. Schmidt in a sponge from the Gulf of Mexico, at the depth of 95 fathoms (Mexico Spong. 3 Th. p. 84, t. ix. fig. 7). They have not previously been met with in the fossil state. Mr. Carter's explanation of the hour-glass form as resulting from flattened lateral palms connected together above and below is quite borne out by our fossils, for, as already mentioned, in one instance (fig. 3) the shaft proper of the spicule is shown distinct from the lateral wings, and this shaft has the axial canal extending through it. The only skeletal spicules in the recent *Guitarra fimbriata* are straight acerates without any distinctive features.

#### *Anchorate Flesh-Spicules of Pseudohalichondria, Carter.*

The spicules described below belong to a peculiar type of anchorate characterized more especially by an unequally expanded shaft and the presence of numerous spines and protuberances both on the shaft and the teeth or palms. In some instances the spines are so developed that the anchorate character of the spicule is masked and it has the appearance of a spinispirular flesh-spicule. As a rule the shafts in these spicules are strongly curved, so that viewed laterally they are G-shaped. The only recent sponge with anchorate flesh-spicules at all comparable with these fossils is *Pseudohalichondria clavilobata*, Carter (Ann. & Mag. Nat. Hist. s. 5, vol. xviii. 1886, p. 454, pl. x. figs. 8 a, d), from the Australian seas, and they are therefore placed in the same genus.

*Pseudohalichondria deformis*, n. sp.—Pl. XI. figs. 8, 9. Spicules equianchorate, subpalmate, with robust, curved, inequally expanded shaft with projecting knobs and protuberances; lateral palms tongue-shaped, uneven, irregularly spined; anterior tubercles

distinct, palms tongue-shaped. Length of spicule  $\cdot 031$  mm., of palms  $\cdot 013$  mm., width across palms  $\cdot 02$  mm., extreme width of shaft  $\cdot 015$  mm. Figs. 8 and 9 represent the lateral and front views respectively of the same spicule. It appears to be distinct from any spicule yet described, and may be termed provisionally *Pseudohalichondria deformis*.

*Pseudohalichondria* (a).—Pl. XI. fig. 10. Equianchorate spicule with irregularly expanded shaft armed with spines; the ends also are armed with prominent conical spines alike on the anterior and lateral teeth. Length of spicule  $\cdot 033$  mm., of the ends  $\cdot 011$  mm., thickness of shaft  $\cdot 016$  mm. Only a front view of this spicule has been recognized.

*Pseudohalichondria* (b).—Pl. XI. figs. 11, 14. Spicules with strongly curved shafts armed on the exterior or convex surface with stout conical spines. The anterior and lateral teeth at both ends are also strongly spined. Length of spicule  $\cdot 02$  to  $\cdot 027$  mm., thickness of shaft  $\cdot 0087$  mm. Only the lateral view of this form is known.

*Pseudohalichondria Oamaruensis*, n. sp.—Pl. XI. figs. 12, 13. Equianchorate spicule with strongly curved shaft, widest in the middle and spined; at either end of the spicule a semicircular notched border and a very prominent curved anterior tooth. Length of spicule  $\cdot 0267$  mm., of the ends  $\cdot 0083$  mm., width  $015$  mm., greatest width of shaft  $\cdot 013$  mm. Fig. 12 is an oblique, and fig. 13 a lateral view of the same spicule. It is a distinctly new form, and may be termed *Pseudohalichondria Oamaruensis*.

Pl. X. fig. 45. Equianchorate spicule having a shaft with an elbow-like curve and armed with stout occasional spines. Teeth short, incurved. Length of spicule  $\cdot 043$  mm., of the teeth  $\cdot 01$  mm., thickness of shaft  $\cdot 0086$  mm. Only a lateral view known.

#### *Sceptrella* or Chessman Flesh-Spicules of Latrunculia, Bocage.

These spicules, for which the name of "*Sceptrella*" was proposed by Mr. Carter (Ann. & Mag. Nat. Hist. s. 5, vol. iii. 1879, p. 358), consist of an upright cylindrical shaft or axis, furnished with stout spines, spined plates, discs, or drums, usually arranged in whorls at irregular intervals, whilst spines either single or in groups radiate from the upper and lower ends of the shaft. The spines themselves not infrequently are provided with smaller

secondary spines. In recent sponges of this genus these flesh-spicules are usually thickly set over the surface, forming a dermal crust or layer, as well as scattered through the soft tissues of the sponge. The skeletal spicules of *Latrunculia* are simple forms of acerates and acuates.

Previous to the 'Challenger' Expedition about four or five species with "Sceptrella" spicules had been described, and the 'Challenger' material yielded four other species. In the Oamaru deposit the sceptrellas are very numerous, and they present an extraordinary variety of form resulting from different modifications of the spined whorls, so that if, judging from the recent sponges, only one or at most two of these modifications are present in a species, there must be a greater number of species present in the Oamaru material than have hitherto been found living at the present time. As fossil, Sceptrella spicules were first noticed in the Jurassic strata of Ilsede, Hanover, by Dr. Rüst ('Palæontographica,' Bd. xxxi. p. 321, pl. xx. figs. 35, 36).

*Latrunculia* (a).—Pl. XI. fig. 15. Sceptrella with short stout shaft terminating at either end with a central prominent conical spine, the base of which is surrounded by a ring of obliquely directed spines; at equal distances on the shaft are two whorls of similar spines projecting directly outwards. All the spines are armed with secondary spines. Length of spicules (including spines) .066 mm., width across whorls .033 mm., thickness of shaft .016 mm. This form is very abundant. It somewhat resembles the sceptrella of *Latrunculia corticata*, Carter (Ann. & Mag. Nat. Hist. s. 5, vol. iii. p. 298, pl. xxvii. fig. 4 a), but it is twice as large and has the terminal spine in addition. Similar but larger forms are present detached in dredgings by H.M.S. 'Egeria' from off the S.W. coast of Australia at depths of 3000 fathoms. A very similar form is also figured by Dr. Rüst from the Jurassic radiolarian marls of Ilsede, Hanover ('Palæontographica,' Bd. xxxi. p. 321, pl. xx. fig. 35).

*Latrunculia* (b).—Pl. XI. fig. 16. Sceptrella with short thick shaft armed with short conical spines at the base, above this are two whorls of stout spines apparently rising from the margins of discs, a third whorl is near the summit, and the apex is formed by a group of upwardly directed spines. Length of spicule .05 mm., width across whorls .036 mm., thickness of shaft .0016 mm. This spicule is also of the same type as the flesh-spicules in *L. corticata*, Carter, and in *Sceptrella regalis*, Osc. Sch., but

differs from both these in size and in the close arrangement of the whorls.

*Latrunculia* (c).—Pl. XI. fig. 17. Sceptrella with stout shaft having obliquely directed spines at its base; in the middle of the shaft a whorl of spines, apparently grouped in fours, and another similarly formed whorl near the summit. The apex consists of a central spine surrounded by smaller ones. Length of spicule .083 mm., extreme width of whorls .056 mm., thickness of shaft .016 mm.

*Latrunculia* (d).—Pl. XI. fig. 18. Sceptrella with oblique furcate spines at the base, a median whorl of simple and furcate spines, and a summit of stout horizontal or oblique spines. The apex consists of a group of slender acute spines. Length of spicule .04 mm., width across whorls .023 mm., thickness of shaft .007 mm.

*Latrunculia* (e).—Pl. XI. fig. 19. Sceptrella having an expanded base of obliquely directed acute spines, a median whorl of horizontal spines of unequal sizes, and a summit whorl of trifurcate spines. At the apex are minutely dentate crests and spines. Length .031 mm., width of central whorl .027 mm., thickness of shaft .0083 mm. This form is of a similar character to the preceding (fig. 18), but it is shorter and more compact.

*Latrunculia* (f).—Pl. XI. fig. 20. Base of shaft expanded, with minute divergent spines, central whorl of horizontal spines, summit expanded and an apex of upright laminae with spined margins. Length of spicule .036 mm., width of whorl .016 mm., thickness of shaft .005 mm.

*Latrunculia* (g).—Pl. XI. fig. 21. Sceptrella with expanded base armed with small simple spines; a median whorl of horizontal spined processes, and a similar but narrower summit whorl. The apex of the shaft is obtusely rounded, with a crest of minute spines. Length of spicule .046 mm., width of median whorl .031 mm., thickness of shaft .011 mm.

*Latrunculia* (h).—Pl. XI. fig. 22. Base of shaft with strongly divergent simple spines, a median whorl of stout horizontally disposed spines, the summit and apex consists of a group of faceted and minutely spined protuberances. Length of spicule .056 mm., width of median whorl .048 mm., thickness of shaft .013 mm.

*Latrunculia* (i).—Pl. XI. fig. 23. Sceptrella with base of stout divergent spines and a median whorl of horizontal spines as in

the preceding form; above is a whorl of vertical laminæ with spined or dentate margins; the apex is conical, spined, with a terminal spire. Length of spicule .058 mm., width of median whorl .04 mm., thickness of shaft .013 mm.

The seven forms described above (Pl. XI. figs. 17-23) are all modifications of a common type which has an expanded base of divergent spines, a median whorl of horizontal spines, and an upper or summit whorl of spines, whilst the apex is pointed or obtusely spined, or of upright laminæ. These spicules are distinct in these details from the sceptrellas of any recent species of *Latrunculia*.

*Latrunculia Oamaruensis*, n.sp.—Pl. XI. fig. 34. Sceptrella with stout, elongate, subfusiform shaft; at the base are three or four whorls of minute spines separated by short interspaces, separated from these by a smooth interval is a whorl of conical horizontally disposed spines or processes, followed above by five other whorls at irregular intervals. At the upper end of the shaft is a whorl of curved spines or plates, and the apex is formed by a stout vertical spine. The spines or processes of the whorls are armed with secondary spines. Length of spicule .206 mm., greatest width of whorls .043 mm., thickness of shaft .016 mm.

Pl. XI. fig. 35. Sceptrella of nearly the same character as the preceding, but the shaft is curved, the spined whorls are much less regular and there are intermediate single spines, whilst the upper end consists of a shallow cup-shaped expansion with a group of spines at the apex, some of which have minute globular heads.

This and the preceding form greatly exceed in size the sceptrellas in any recent species; they probably belong to the same species, which may be provisionally named *Latrunculia Oamaruensis*.

*Latrunculia* (k).—Pl. XI. fig. 36. Sceptrella with straight, robust, subfusiform shaft, the base furnished with three whorls of minute spines; above these are five whorls of stout conical processes, secondarily spined; an upper whorl of curved spines or plate-like hooks, and at the apex several projecting spines. Length of spicule .133 mm., width across whorls .04 mm., thickness of shaft .013 mm. In character this spicule resembles the preceding, but it is much shorter.

*Latrunculia* (l).—Pl. XI. fig. 37. Sceptrella with stout sub-cylindrical shaft having four or five whorls of minute spines at the base, succeeded above by three whorls of spines or processes.

In the lower of these the spines are directed obliquely downwards, whilst in the two higher whorls they curve towards the apex. The spines in these whorls are thickly set with secondary spines. At the upper end is a whorl of upwardly curved spines, and a single prominent spine forms the apex. Length of spicule  $\cdot 093$  mm., greatest width of whorls  $\cdot 043$  mm., thickness of shaft  $\cdot 013$  mm.

*Latrunculia* (m).—Pl. XI. fig. 38. Shaft subcylindrical, with two whorls of small spines at the base, succeeded above by an inverted saucer-like disc with dentated margin, and a similar but smaller disc with the concavity upwards. At the summit is a whorl of curved teeth or spines. Length of spicule  $\cdot 043$  mm., width of lower disc  $\cdot 027$  mm., thickness of shaft  $\cdot 0075$  mm.

*Latrunculia* (n).—Pl. XI. figs. 39, 40. Sceptrella with slender cylindrical shaft having at the base two or three whorls of minute spines, and in the middle portion of the shaft two whorls of lobate plates with spined margins. At the summit a whorl of curved blunted spines. Fig. 11 shows, on the scale of 600 diameters, one of the lobate whorls as seen from above, the section of the circular shaft with the axial canal can be distinguished. Length of spicule  $\cdot 075$  mm., width of whorl  $\cdot 033$  mm., thickness of shaft  $\cdot 006$  mm.

The six forms described above (Pl. XI. figs. 34–39) are modifications of a common plan. Recent flesh-spicules of this type are present in the following species:—*Latrunculia cratera*, Bocage (Journ. d. Sci. Lisbonne, no. 4, 1869, pl. xi. fig. 2); *L. Bocagei*, Ridley & Dendy, *L. brevis*, Ridley & Dendy (Chall. Rep. vol. xx. pp. 237, 238, pl. xlv. figs. 8 a, 10 a); *L. purpurea*, Carter (Ann. & Mag. Nat. Hist. ser. 5, vol. vii. 1881, p. 380, pl. xviii. figs. 5 b, c); and also in detached spicules described by Mr. Carter from deep water off the Seychelles (Ann. & Mag. Nat. Hist. ser. 5, vol. iii. 1879, p. 358, pl. xxix. figs. 14, 17); and they differ from the fossil forms only in the details of size and the disposition of the spines, &c.

*Latrunculia* (o).—Pl. XI. fig. 24. Sceptrella with base of shaft expanded, with projecting simple spines; succeeded above by a nearly median whorl of depressed spines and an upper whorl of curved spines. The apex consists of a group of thin vertical laminæ with their edges outwards. Length of spicule  $\cdot 04$  mm., width of lower whorl  $\cdot 016$  mm., thickness of shaft  $\cdot 006$  mm.

*Latrunculia* (p).—Pl. XI. fig. 25. Spicule with toothed base, an inverted lower disc-like whorl with deutate margins, and a similar but upright summit whorl. These whorls are connected so as to form a drum with constricted centre. The apex is conical, terminated by a single spine. Length of spicule  $\cdot 034$  mm., width of whorls  $\cdot 018$  mm., thickness of shaft  $\cdot 006$  mm.

Pl. XI. fig. 26. Sceptrella similar to the preceding, but with a tiara-like apex of three curved spines.

*Latrunculia* (q).—Pl. XI. fig. 27. Small sceptrella with base of projecting spines, a thick inverted disc-shaped lower whorl, with spined surface and margins; at the upper end a cup-shaped whorl with a dome-shaped, minutely-spined apex. Length of spicule  $\cdot 02$  mm., width of lower whorl  $\cdot 015$  mm., thickness of shaft  $\cdot 005$  mm.

*Latrunculia* (r).—Pl. XI. fig. 28. Shaft of spicule with an expanded dentate base, a median disc with apparently smooth margins, summit cup-like with a semi-globate apex with blunted spines. Length of spicule  $\cdot 036$  mm., width of lower whorl  $\cdot 026$  mm., of shaft  $\cdot 011$  mm.

*Latrunculia* (s).—Pl. XI. fig. 29. Sceptrella with expanded base of divergent spines, a short robust shaft, and at the top a group of laminae having a plume-like arrangement. Length of spicule  $\cdot 026$  mm., width of base  $\cdot 018$  mm., thickness of shaft  $\cdot 007$  mm.

Pl. XI. fig. 31. Spicule of the same character as the preceding, but the spines of the base are larger and the laminae at the apex are vertical. Length of spicule  $\cdot 035$  mm.

Pl. XI. fig. 30. Sceptrella with an expanded base of furcate, claw-like spines, a short cylindrical shaft with a group of spreading furcate spines at the summit. Length of spicule  $\cdot 023$  mm., width  $\cdot 016$  mm., thickness of shaft  $\cdot 0047$  mm.

This and the two preceding forms (figs. 29, 30, 31) differ from what may be considered the normal type of "sceptrella" in not having a median whorl, and the spicule is reduced to an expanded spined base and divergent laminae or spines at the summit of a short shaft.

*Latrunculia obtusa*, n. sp.—Pl. XI. fig. 32. Sceptrella with sub-cylindrical, obtusely ended shaft with two circular discoid whorls in the upper half, their margins inflated. The summit of the shaft is obtuse conical. The entire surface of shaft and whorls set with minute spines. Length of spicule  $\cdot 053$  mm., width of



whorl  $\cdot 023$  mm., thickness of shaft  $\cdot 01$  mm. A detached recent spicule from near the Seychelles has been figured by Mr. Carter which has considerable resemblance to this fossil (Ann. & Mag. Nat. Hist. s. 5, vol. iii. pl. xxix. fig. 20). Spicules of the same type but considerably smaller also occur in *Latrunculia* (?) *acerata*, Ridley and Dendy (Chall. Rep. vol. xx. p. 239, pl. xxix. fig. 3 b). The present fossil indicates a distinct species, which may be termed *Latrunculia obtusa*.

*Latrunculia* (t).—Pl. XI. fig. 33. Shaft cylindrical, with a slight circular expansion at the base; slightly above the middle a thin-edged circular disk, and a similar but slightly smaller disk at the summit of the spicule. The surface appears to be smooth throughout. An axial canal extends through the shaft. Length of spicule  $\cdot 026$  mm., width of whorl  $\cdot 17$  mm., thickness of shaft  $\cdot 005$  mm. This spicule is of the same character as the preceding, but the upper disc is terminal.

*Latrunculia* (u).—Pl. XI. fig. 45. Spicule with stout short shaft, angular and pointed at the lower end, and at the summit a dome-shaped apex. In the upper portion are two whorls of rounded or ovate nodes, whilst at the lower there are two pairs of elongate ovate processes extending horizontally from the shaft. Length of spicule  $\cdot 033$  mm., greatest width  $\cdot 028$  mm. An axial canal traverses the shaft, terminating above with a small inflation. This peculiar form varies considerably from the normal flesh-spicules of *Latrunculia*, but it seems more nearly allied to these than to the spicules of *Thoosa* described below.

#### *Flask-shaped Flesh-Spicules of Latrunculia* (?), *Bocage*.

*Latrunculia* (v).—Pl. XII. fig. 1. Spicule with a depressed globular body, a short neck, and a spined summit. The globate portion is studded with stout short conical spines, obtusely pointed and projecting directly outwards, the neck is without spines, whilst the summit is slightly inflated and covered with somewhat claw-shaped spines. At the apex is a single vertical spine. Length of spicule  $\cdot 043$  mm., thickness of body  $\cdot 035$  mm.

Pl. XII. fig. 2. Spicule with subangular body with wide base. The upper portion conical. The body is armed with long, stout, obtuse spines, near the summit is an inflated portion covered with hooked spines, and at the apex is a prominent vertical spine. An axial canal extends from the apex to a little below the centre of

the body, where it terminates in a slight inflation. Length of spicule  $\cdot 037$  mm., greatest thickness  $\cdot 029$ .

In no recent sponge, so far as we are aware, have any flesh-spicules been described which resemble at all closely these peculiar forms. The presence of a simple axial canal indicates that they belong to Monactinellid sponges, and as there is a certain correspondence in form to some of the sceptrellas of *Latrunculia*, it seems preferable to place them provisionally under this genus. It is highly probable that, like the sceptrellas, they formed a kind of surface-armour on the dermal layer of the sponge, having the spined apices projecting outwards.

*Flesh-Spicules of 'Thoosa, Hancock.*

*Thoosa Hancocki*, n. sp.—Pl. XI. fig. 41. Spicule stout, cylindrical, barrel-shaped, with a whorl of six subspherical tubercles at the top and bottom, and a single tubercle supported on a short stem at either end. The tubercles of the body are sessile, their surfaces are covered with minute spines or pustules. An axial canal is shown as a thin rod in the centre of the body or shaft. Length of spicule  $\cdot 022$  mm., width  $\cdot 015$  mm., thickness of tubercles  $\cdot 0045$  mm.

Pl. XI. fig. 42. Spicule of the same character as the preceding, but smaller and less robust. Length of spicule  $\cdot 018$  mm., width  $\cdot 013$  mm., thickness of tubercles  $\cdot 003$  mm. This and the preceding form are precisely similar in character to the so-called mulberry flesh-spicules in the tropical boring sponges *Thoosa cactoides* and *T. bulbosa*, Hancock (Ann. & Mag. Nat. Hist. vol. iii. 1849, pp. 330, 346, pl. xii. fig. 10 *a*), and also to those of *T. socialis*, Carter (Ann. & Mag. Nat. Hist. s. 5, vol. vi. 1880, p. 56, pl. v. fig. 23 *a*), from the Gulf of Manaar, but they are smaller generally and the tubercles less developed, whilst the shafts are more robust. The recent spicules form a dense dermal layer to the sponges and appear to be the only spicules present, though in *T. socialis* Mr. Carter describes some minute circular discs as well. As the fossils represent a distinct species, it may be named *Thoosa Hancocki*.

Pl. XI. fig. 43. Spicule with short barrel-shaped shaft and two whorls of tubercles, four apparently in each; the tubercles are supported on short stalks, similar to those of the terminal tubercles at either end. Length of spicule  $\cdot 024$  mm., width

·016 mm., thickness of tubercles ·0025 mm. This form is perhaps only a variety of the preceding.

*Thoosa* (a).—Pl. XII. fig. 3. Spicule with short barrel-shaped body, having above and below three curved obtuse processes slightly furcate at the extremity which project outwards. At either end of the body is a similar blunt process with terminal spines, that at one end is slightly larger than the opposite one. Length of spicule ·03 mm., greatest width ·02 mm. In its general form this spicule resembles the normal flesh-spicules of *Thoosa*, but the tubercles are replaced by furcate and spined processes.

*Sceptrelliform Flesh-Spicules of Alectona, Carter.*

Pl. XI. fig. 44. Spicule with straight subfusiform shaft, obtuse at both ends, an expanded central portion with two whorls of spherical bead-like bodies supported on short stalks, about eight or nine in each whorl. The surface of the shaft is minutely spined, and an axial canal extends through it opening at both ends. Length of spicule ·042 mm., width across whorls ·011 mm., thickness of shaft ·005 mm. This form corresponds very closely with the flesh-spicule of *Alectona* (*Corticium*) *Wallichii*, Carter (Ann. & Mag. Nat. Hist. s. 5, vol. iii. 1879, p. 353, pl. xxix. fig. 8).

*Spirular Flesh-Spicules of Spirastrella, Osc. Schmidt.*

*Spirastrella* (a).—Pl. XII. figs. 4, 5. Spicules with a short sinuous shaft from which large conical, obtusely pointed spines project in different directions. Length of spicule ·03 to ·033 mm., thickness ·011 to ·016 mm. These spicules so closely resemble in form and size the flesh-spicules of *Spirastrella cunctatrix*, Osc. Schm. (Algier. Spong. p. 17, t. iii. fig. 8), that they might be considered to belong to this species, which is widely distributed, Mr. Carter having recorded it from the Australian Seas (Ann. & Mag. Nat. Hist. s. 5, vol. xvii. 1886, p. 113). They also occur in the 'Egeria' dredgings off the S.W. coast of Australia at a depth of 2479 fathoms. The skeletal spicules of the recent sponge are either pin-shaped or acuates, and of these there are great numbers in the Oamaru material. Fossil forms closely similar are figured by Dr. Rüst from the Jurassic strata of Ilse, Hanover ('Palæontographica,' Bd. xxxi. pl. xx. figs. 37, 38).

*Spirastrella* (b).—Pl. XII. fig. 6. Spirule having a single curve, the shaft is slightly swollen at the ends, which are thickly

set with spines, at the bend of the curve is another group of spines, whilst the intermediate portion of the shaft is smooth. Length of spicule  $\cdot 025$  mm., thickness (including spines)  $\cdot 015$  mm.

*Spirastrella* (c).—Pl. XII. fig. 7. Spirule with short and strongly curved axis and stout conical spines somewhat thickly set over the spicule and more particularly at the ends, so that its appearance is rather that of a globate. Length of spicule  $\cdot 025$  mm., thickness  $\cdot 02$  mm. This spicule resembles the spirule of *Spirastrella transitoria*, Ridley ('Alert' Rep. p. 623, pl. liv. fig. *q'*), but it is considerably larger.

*Spirular Flesh-Spicules of Pronax, Gray (=Cliona,  
Hancock, pars).*

*Pronax* (a).—Pl. XII. figs. 8, 8a. Spicules cylindrical, smooth, truncate at the ends, consisting of four or five unequal twists. Length  $\cdot 04$  to  $\cdot 046$  mm., thickness  $\cdot 0033$  mm. These spicules resemble the forms discovered by Hancock in several species of boring sponges, referred by him to *Cliona*, but subsequently placed by Gray in the genera *Pronax* and *Pione* (Proc. Zool. Soc. 1868, pp. 525–6). They approach nearest in outline those of *Cliona gracilis*, Hancock (Ann. & Mag. Nat. Hist. s. 3, vol. xix. 1867, p. 238, pl. vii. fig. 4). Mr. Carter has figured a similar but larger form in *Cliona abyssorum* (Ann. & Mag. Nat. Hist. s. 4, vol. xiv. 1874, p. 249, pl. xiv. fig. 33), from the depths of the Atlantic.

*Pronax* (b).—Pl. XII. fig. 9. Spirule elongate, cylindrical, truncate at the ends, having about six bends or twists; at each bend or curve there are three or four slender spines projecting outwards, the rest of the spicule appears to be smooth. This form closely resembles the spicules of *Pronax (Cliona) lobata*, Hancock, sp. (Ann. & Mag. N. H. s. 3, vol. xix. 1867, p. 239, pl. vii. fig. 6). Similar flesh-spicules are also figured by Ridley in *Spirastrella vagabunda* and *S. congenera* ('Alert' Rep. p. 468, pl. xliii. figs. *d'*, *e'*), and by Mr. Carter in *Rhaphidistia spectabilis* (Ann. & Mag. Nat. Hist. s. 5, vol. iii. 1879, p. 300, pl. xxvi. fig. 14a).

*Summary of the Genera and Species of Monactinellid Sponges  
represented in the Oamaru Deposit.*

We give below a list of the genera, and an approximate estimate of the number of species in each, which appear to be represented by the detached spicules referred to in detail in the preceding pages. With one or two exceptions the genera are arranged according to the classification of Ridley and Dendy in their 'Challenger' Report and of Vosmaer in the Monograph on the Porifera in Bronn's 'Klass. u. Ordn. des Thierreichs.'

Division MONACTINELLIDÆ, Zittel.

Group HALICHONDRIINA, Vosmaer.

Family HOMORRHAPHIDÆ, Ridley & Dendy.

No. of Species.	Genus.	Flesh- Spicules.	Skeleton- Spicules.
(?)	<i>Reniera</i> (?), Nardo .....		S.S.
(?)	<i>Chalina</i> (?), Grant .....		S.S.

Family DESMACIDONIDÆ.

2	<i>Forcepia</i> , Carter .....	F.S. &	S.S.
1	<i>Acarnus</i> , Gray .....	F.S. &	S.S.
3	<i>Hamacantha</i> , Gray .....	F.S. &	S.S.
10	<i>Esperella</i> , Vosmaer (= <i>Esperia</i> , Nardo).	F.S. &	S.S.
4	<i>Esperiopsis</i> , Carter .....	F.S. &	S.S.
1	<i>Cladorhiza</i> , Sars .....	F.S. &	S.S.
4	<i>Chondrocladia</i> , Wyv. Thomson .....	F.S. &	S.S.
12	{ <i>Desmacidon</i> , Bowerbank .....	F.S. &	S.S.
	{ <i>Myxilla</i> , Osc. Schmidt .....		
1	<i>Iophon</i> , Gray .....	F.S. &	S.S.
1	<i>Amphilectus</i> , Vosmaer .....	F.S. &	S.S.
2	<i>Guitarra</i> , Carter .....	F.S. &	S.S.
1	<i>Melonanchora</i> , Carter .....	F.S. &	S.S.
4	<i>Pseudohalichondria</i> , Carter .....	F.S. &	S.S.
2	<i>Plocamia</i> , Osc. Schmidt .....		S.S.

Family AXINELLIDÆ, Ridley & Dendy.

(?)	<i>Axinella</i> (?), Osc. Schmidt .....	S.S.
(?)	<i>Hymerhaphia</i> (?), Bowerbank .....	S.S.

## Group CLAVULINA, Vosmaer.

## Family SPIRASTRELLIDÆ, Ridley &amp; Dendy.

No. of Species.	Genus.	Flesh- Spicules.	Skeleton- Spicules.
2	<i>Spirastrella</i> , Osc. Schmidt .....	F.S. &	S.S.
2	<i>Pronax</i> , Gray .....	F.S. &	S.S.

## Family LATRUNCULIDÆ, nov.

15	<i>Latrunculia</i> , Bocage .....	F.S. &	S.S.
2	<i>Thoosa</i> , Hancock .....	F.S. &	S.S.
1	<i>Alectona</i> , Carter .....	F.S. &	S.S.

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 70

In this list 24 genera are enumerated and 70 species. Four genera are considered doubtful, and no species are placed under them, since they are only represented by skeleton-spicules. Of the other genera, distinctive flesh-spicules have been recognized in all, with the exception of *Plocamia*, Osc. Sch., and in this genus the dumb-bell forms of skeleton-spicules are sufficiently characteristic. In estimating the number of species we have taken into consideration the fact that in recent sponges of this group there are many characterized by only a single distinctive form of flesh-spicule, whilst in others there are two or occasionally three distinctive forms.

It will be seen that the genera most numerous represented are *Esperella* with 10 species, *Desmacidon* and *Myxilla* with 12 species between them, and *Latrunculia* with 15 species. We venture to consider this latter genus as the type of a new family, distinguished by sceptrelliform flesh-spicules. Hitherto, the genus has been placed in the *Spirastrellidæ* by Ridley and Dendy, but there does not appear to be any form-relationship between the spiral flesh-spicules of this last-named family and the sceptrellas of *Latrunculia* and its allied genera *Thoosa* and *Alectona*. By Vosmaer *Latrunculia*, or its synonym *Sceptrella*, was placed in the *Desmacidonidæ* on the supposition that it possessed an anchorate flesh-spicule, but, as already mentioned, this anchorate is in all probability adventitious.

The significance of so many species of Monactinellid sponges from this single fossil deposit will appear the greater from the fact that the 'Challenger' Expedition only obtained 16 recent

species of this group of sponges from the entire geographical area of the Southern Pacific, in which New Zealand is placed, whilst from the Indo-Australian area, which proved the most prolific in species of this group, only 74 species were obtained (Chall. Rep. vol. xx. p. 259). From the vicinity of New Zealand itself not a single species of Monactinellid was obtained by the 'Challenger.'

## II. TETRACTINELLIDÆ, *Marshall*.

### Family CORTICIDÆ, *Vosmaer*.

#### *Candelabra Spicules of Corticium, Osc. Schmidt.*

*Corticium* (a).—Pl. XII. fig. 10. Candelabrum with basal portion of 8 or 9 stout conical rays and the crown or summit of 7 or 8 unequal, stout, straight or curved tapering rays, with slightly inflated summits. The exterior or convex margin of these rays is spined or tuberculate. Length of spicule ·05 mm., width across ·05 mm.; length of basal rays ·018 mm., width ·01 mm.; length of head-rays ·02 mm.

Pl. XII. fig. 11. Candelabrum with base of stout conical rays about 9 in number, the summit of four unequal, slightly curved rays with slightly inflated heads, their outer margins spined. Length of spicule ·035 mm., width the same; basal rays, length ·015 mm., thickness ·005 mm.; summit-rays, length ·015 mm., thickness ·0033 mm. This is a smaller spicule than the preceding and it has fewer summit-rays, but it is probable that both forms may belong to the same species. These spicules are much stouter than those of the recent *Corticium candelabrum*, Osc. Schmidt, and the summit-rays are inflated instead of pointed (Adriat. Spongien. p. 42, pl. iii. fig. 25).

*Corticium* (b).—Pl. XII. fig. 12. Candelabrum with about 15 basal rays and 10 or more in the summit or crown. These latter are slightly incurved, claw-shaped, and terminate in an obtuse point, their convex margins are spined. The basal rays in this form are also set over with small spines. Length of spicule ·045 mm., extreme width ·038 mm.; length of basal rays ·018 mm., thickness ·005 mm.; summit-rays, length ·01 mm., thickness ·006 mm. The pointed termination of the head-rays and the spination of the basal rays indicate that this form belongs to a species distinct from the preceding. A detached

spicule of similar form to the above occurs in the dredgings by the 'Egeria' off the S.W. of Australia at a depth of 2479 fathoms.

Pl. XII. fig. 13. Candelabrum with about eight basal rays and a crown of six short subequal claw-like rays, supported on a distinct neck or pedestal. The rays spined on their convex margins. The basal rays appear to be smooth. In some of the rays axial canals can be distinguished. Length of spicule  $\cdot 031$  mm., width of base  $\cdot 03$  mm.; length of basal rays  $\cdot 013$  mm., thickness  $\cdot 006$  mm.; summit-rays, length  $\cdot 0067$  mm., thickness  $\cdot 0035$  mm.

Pl. XII. fig. 13 a. Candelabrum with about 12 basal rays, apparently resulting from the quadripartite division of each of the three normal rays; the rays are either simple, slightly curved, and obtusely pointed, or slightly furcate at the extremities. The summit consists of four pointed smooth rays springing from a short pedestal. Length of spicule  $\cdot 031$  mm., extreme width  $\cdot 035$  mm., length of basal rays  $\cdot 015$  mm., thickness  $\cdot 0046$  mm. The summit-rays are of nearly the same size as the basal. Fig. 14 is of the same character, but smaller.

Pl. XII. fig. 15. Candelabrum with nine basal rays resulting from the trifurcation of the three normal rays, and about eight or nine summit-rays which are short, claw-shaped, and apparently smooth, rising from a short pedestal. Of nearly similar dimensions to fig. 13. It is probable that this form, with the three preceding, may belong to the same species, and with these the form represented by fig. 12 may be included, though it is larger and more distinctly spined. Of a similar type to these spicules may be mentioned the form described by Wisniowski (*Kosmosu Roczn.* xiv, zes. vii.-viii. 1889, p. 9, pl. fig. 11) from the Jurassic strata near Cracow, but in this the summit-rays are reduced to three or four.

*Corticium* (c).—Pl. XII. fig. 16. Candelabrum in which each of the normal basal rays is divided into four stout conical rays, whilst the summit consists of four approximately straight, slightly divergent rays, which are sessile and slightly quadripartite at their ends, each division terminating in a small tubercle. Height of spicule  $\cdot 027$  mm., width  $\cdot 031$  mm. Summit-rays, length  $\cdot 011$  mm., thickness  $\cdot 0033$  mm. The summit-rays of this form are very different from the preceding, and it probably represents a distinct species.

*Corticium* (d).—Pl. XII. fig. 17. Candelabrum with the



basal rays very unequally divided, resulting either in a simple slight furcation near their extremities or in a division into three conical rays, as in the preceding spicules. The summit is formed by three simple, slightly recurved rays on a short base. Height of spicule  $\cdot 021$  mm., width of base  $\cdot 025$  mm.; summit-rays, length  $\cdot 006$  mm., thickness  $\cdot 0033$  mm. In the simple character of the summit-rays and unequal division of the basal rays, this form agrees with the spicules of *Corticium versatile*, Osc. Sch. (Mexican Spong. p. 69, pl. ix. fig. 5), from St. Vincent, at a depth of 95 fathoms.

*Corticium* (e).—Pl. XII. fig. 18. Candelabrum in which the three basal rays are equal and simple, with an occasional spine here and there; the summit consists of three or four minute pointed rays and one or two spines. Length of basal rays  $\cdot 031$  mm. each, thickness  $\cdot 006$  mm. This form also corresponds in character with the spicules of *C. versatile*, Osc. Sch.

Pl. XII. fig. 19. Candelabrum with simple, elongate, pointed basal rays and a summit of about six divergent rays, which are slightly bi- and trifurcate at their extremities. Length of basal rays  $\cdot 036$  mm. each, thickness  $\cdot 0053$  mm.; summit-rays, length  $\cdot 012$  mm., thickness  $\cdot 0033$  mm. In the terminal character of the summit-rays this spicule resembles that represented by fig. 16.

The number of the rays in the candelabra spicules of *Corticium*, as remarked by Osc. Schmidt (Mexic. Spong. p. 69), varies in the same species to such an extraordinary extent, according to the degree of subdivision of the four normal rays of the typical calthrops spicule, that it is not easy to determine the number of species which these detached spicules may represent. But the character of the summit-rays of the spicules gives a probable clue, for whilst some are capped by small tubercles, others are claw-shaped and pointed, and others, again, have furcate ends, and each of these different forms may belong to a separate species; and in this case three, if not four, species are present in the Oamaru material. This genus is very sparsely represented in existing seas; not more than three or four species are known, and these are found in the Adriatic, off the coast of Algiers, Zebu, and St. Vincent. Only a single detached spicule has previously been discovered as fossil in Jurassic strata near Cracow.

*Modified Stellate and Calthrops Spicules of Corticium.*

Pl. XII. figs. 22-29. Spicules in which the number of rays varies from 3 to 14. In all the forms the rays are short, obtusely pointed, and frequently unequal in size in the same spicule. The simplest is a 3-rayed form (fig. 28); the rays are .03 mm. in length by .0067 mm. in thickness. Fig. 27 represents a minute calthrops spicule in which the rays are .026 mm. in length. Fig. 29 is also of a calthrops type, but it has five rays, about .016 mm. in length. In the other forms (figs. 22-26) the rays are more numerous, ranging from 6 to 14, and the spicules exhibit a stellate arrangement. The rays in these are short and obtuse, and appear very different from those of ordinary stellates. The diameter of these spicules ranges from .021 to .04 mm. In their general appearance they resemble spicules of *Corticium*; and in a recent Adriatic species, *C. stelligerum*, Osc. Sch. (Algier. Spong. p. 25, t. iii. fig. 6 b), there are stellate and small calthrops spicules, somewhat similar to these fossils.

Pl. XII. figs. 30, 31, 32.—Small spicules with from 4 to 7 rays, which do not radiate from a common centre but from a short linear axis. The rays are elongated, pointed, and together with the central axis are traversed by canals which open at their extremities. In fig. 30 there are 4 rays, .075 mm. in length, which are in different planes. In fig. 31 there are six subequal rays, .0217 mm. in length, which form, as it were, a double tripod. In fig. 32 there is a short central curved axis with three elongate rays at either end, and an additional ray starting from the middle of the axis. The rays in this form are minutely tuberculate, and .021 mm. in length. These spicules can only provisionally be placed under *Corticium*, they may possibly belong to some other tetractinellid genus. In *Corticium stelligerum*, Osc. Sch., referred to above, there are some peculiar stellates in which the rays are given off from a thickened or elongate axis.

*Candelabra Spicules of Plakina, Schulze.*

*Plakina australis*, n. sp.—Pl. XII. fig. 20. Candelabrum with slightly curved tapering shaft and at its summit numerous curved rays, furcate at their ends. The rays are apparently 12 in number, and grouped in systems of four. Length of spicule

·033 mm., of the shaft ·025 mm.; length of summit-rays ·0083 mm. In the number of the summit-rays this form corresponds with the spicules of *Plakina trilopha*, Schulze (Zeitsch. f. wiss. Zool., Bd. xxxiv. (1880) p. 407, pl. xxi. figs. 12 a,  $\beta$ ,  $\eta$ ), but the rays in these latter are simply pointed.

Pl. XII. fig. 21. Spicule with a single, straight, tapering shaft which bifurcates at the summit and gives off on either side three pairs of short curved rays, with bifid ends. Length of spicule ·05 mm., of shaft ·033 mm., thickness of shaft ·003 mm.; length of summit-rays ·01 mm. This and the preceding form (fig. 20) probably belong to the same species, which may be termed *Plakina australis*. Spicules of this genus have not been previously met with as fossil; the existing forms are only known from the Mediterranean.

*Calthrops, or four-rayed Spicules of Pachastrella, Osc. Schmidt.*

Pl. XIII. fig. 35. Calthrops with three subequal rays and one ray shorter than the others. Two of the rays are slightly furcate, and two simple and pointed; axial canals are present in all. Longest ray ·17 mm. by ·023 mm.

Pl. XIII. figs. 36, 37, 38, 40. Calthrops spicules of different sizes, with smooth simple rays, which vary in length from ·023 to ·23 mm., and in thickness from ·0066 mm. to ·075 mm. In another specimen the rays are ·8 mm. in length.

Pl. XIII. fig. 39. Calthrops with rays unequal in length; three are smooth, whilst the other is thickly set with small conical spines, and in this ray alone is an axial canal visible. The longest ray is ·085 mm. by ·001 mm. in thickness.

As a rule the calthrops spicules in the Oamaru material are much smaller than those which are present in the Cretaceous and older rocks. They are fairly abundant in the coarser portions of the deposit associated with the large trifid spicules of *Geodites*, &c.

*Spined Calthrops Spicule of unknown Sponge.*

Pl. XII. fig. 37. Small calthrops spicule with short, conical, obtuse rays, armed with strong projecting spines. Length of rays ·021 mm., thickness ·005 mm. Detached spicules of a similar character, but larger than these fossils, are figured by Bowerbank in a recent undescribed sponge from Freemantle,

Western Australia (Mon. Brit. Spong. vol. i. p. 268, pl. x. figs. 235, 236).

*Trifid Skeletal Spicules of Triptolemus, Sollas.*

*Triptolemus australis*, n. sp.—Pl. XIII. fig. 34. Spicules with a short fusiform shaft, pointed at both ends, from the centre of which three divergent rays extend horizontally and dichotomize three and occasionally four times. The rays are cylindrical or compressed, smooth, those of the second or third subdivision not always in one plane. All the rays are traversed by axial canals, which open at their extremities. Diameter of spicule .3 mm., thickness of primary rays .03 mm. Sponges with spicules similar to these were first described by Mr. Carter as *Pachastrella intexta* and *P. parasitica* (Ann. & Mag. Nat. Hist. s. 4, vol. xviii. 1876, pp. 409–10, pl. xv. fig. 41, pl. xvi. fig. 50). Subsequently Mr. Carter placed these forms under the genus *Samus* (Ann. & Mag. Nat. Hist. s. 5, vol. vi. 1880, p. 60), and they have since been placed in a distinct genus by Prof. Sollas (Chall. Report, vol. xxv. p. 93). It is very doubtful if the type species, *T. cladosus*, Sollas, is distinct from *T. parasiticus*, Carter, sp. The Oamaru specimens are notably larger than the spicules of recent forms, and they probably indicate a new species, which may be provisionally termed *Triptolemus australis*.

*Trifid Spicules of Ditriænella*\*, n. g.

*Ditriænella Oamaruensis*, n. sp.—Pl. XII. figs. 34, 35. Spicules with fusiform shaft, pointed at both ends, and with two whorls of trifid rays. Each whorl is at an equal distance from the end of the shaft, and there is a short interspace in the centre of the shaft between the whorls. The normal three rays of each whorl are bifurcate; the rays are nearly horizontally extended, smooth, conical and obtusely pointed. Axial canals traverse the shaft and all the rays, and open at their ends. Length of shaft .19 mm., thickness .025 mm. Length of rays .04 to .075 mm., thickness .012 mm. Detached spicules of a similar character to these forms are figured by Bowerbank under the names of 'Furcated spiculated biternate,' and described as interstitial tension spicula of *Farrea occa* (Mon. Brit. Spong. vol. i. p. 261, pl. ix. fig. 200 ;

\* *τρίαινα*, a trident, dimin.

Proc. Zool. Soc. 1869, p. 341, pl. xxiv. fig. 6), from the Seychelle Islands. It is evident, however, that these spicules belong to Tetractinellid sponges, and in the position and character of the trifid rays they bear a certain resemblance to the spicules of *Triptolemus*, Sollas, with the difference, however, that there are two whorls of trifid rays instead of one. This difference seems to be of generic value, and we therefore propose to consider these double-trifid spicules as belonging to a new genus and species under the name of *Ditriænella Oamariensis*.

*Ditriænella* (a).—Pl. XII. fig. 36. Spicules of the same character as the preceding, but very much smaller; the shaft and rays are armed throughout with conical spines; the rays of the whorls are simple, and not furcate. Length of spicule 0.59 mm., thickness of shaft 0.07 mm. Length of rays 0.23 mm.

*Acerate and Trifid Spicules of Geodites, Carter, Stelletta,  
Osc. Sch., and allied Genera.*

Pl. XIII. figs. 1, 2. Fusiform acerate spicules, smooth, slightly curved, tapering to acute points. Length from 1.55 mm. to 3.25 mm., thickness about 1 mm. The larger size of the spicules as compared with the corresponding forms figured on Pl. VII., indicate that they belong to Tetractinellid sponges. These spicules are common to several genera of this division. There are in the deposit numerous forms intermediate in size between those figured.

*Geodites* (a).—Pl. XIII. figs. 3, 4, 5. Trifid spicules with slightly curved tapering shafts and short head-rays projecting obliquely forwards. The rays are either simple (fig. 5) or furcate (figs. 3, 4). Length of spicules 2.7 mm. to 3.95 mm., thickness of shaft 1 mm.; length of head-rays .25 to .32 mm. These three forms probably belong to the same species.

Pl. XIII. fig. 19. Anchor trifid spicule; shaft straight, slender, very gradually tapering, head rounded, the three simple rays evenly recurved. Total length uncertain, thickness of shaft 0.5 mm., length of head-rays .24 mm. This form probably belongs to the same species as the trifid spicules referred to above.

Similar detached trifid spicules have been described by Mr. Carter from the Lower Greensand of Haldon, Devonshire, under the name of *Geodites Haldonensis* (Ann. & Mag. Nat. Hist. s. 4, vol. vii. 1871, p. 129, pl. x. figs. 58-67); they also occur in the

same formation in Kent and in the Upper Chalk of Norfolk. Very similar spicules both in form and proportion occur in the recent *Stelletta* (*Anthastra*) *pyriformis*, Sollas, sp. (Chall. Rep. vol. xxv. p. 146, pl. xv. figs. 3-7), from Port Jackson, at depths of from 30-35 fathoms.

*Geodites* (b).—Pl. XIII. fig. 6. Trifid spicule, with straight, scarcely tapering shaft and small furcate head-rays. The shaft is incomplete, the portion remaining is 3·25 mm. in length and ·1 mm. in thickness; the head-rays are ·17 mm. long.

Pl. XIII. figs. 7, 8. Trifid spicules with straight, stout, tapering shafts; head-rays simple or furcate, their ends nearly horizontal or slightly recurved. Axial canals distinctly shown in the shaft and head-rays. Length of spicule ·9 mm., thickness of shaft ·075 mm. to ·1 mm.; length of head-rays ·2 mm.

*Stelletta* (a).—Pl. XIII. figs. 9, 10. Trifid spicules with stout tapering shafts and short simple head-rays, projecting obliquely forwards or slightly recurved at the ends. Length of spicule 1·75 to 2·6 mm., thickness of shaft ·09 mm.; length of head-rays ·225 mm. Similar forms occur in the Upper Chalk of Norfolk (Hinde, Foss. Sponge Spic. pl. iii. figs. 7, 10) and in the recent *Stelletta reticulata*, Carter (Ann. & Mag. Nat. Hist. s. 5, vol. xi. 1883, p. 352, pl. xiv. fig. 4 b), from the S. coast of Australia.

Pl. XIII. figs. 11-15. Trifid spicules with straight or curved tapering shafts and short head-rays, either simple or furcate. Fig. 11, which is much smaller than the others, is only ·46 mm. in length by ·04 mm. in thickness; the head-rays are nearly horizontal and ·084 mm. in length. In figs. 12, 13 the spicules are 1·3 mm. in length and about ·18 mm. in thickness; the head-rays, which are furcate and project obliquely forwards, measure ·3 mm. in length. In figs. 14, 15 the spicules are from ·95 to 1·5 mm. in length; the shafts are ·09 mm. in thickness, and the small simple pointed head-rays are only ·1 mm. long. These trifid spicules probably represent two or three species of *Geodites* or *Stelletta*.

Pl. XIII. figs. 16, 17. Trifid spicules with elongate shafts and relatively long, simple head-rays extending nearly directly forwards. The shafts are from ·04 to ·09 mm. in thickness: in fig. 16 the head-rays are ·24 mm. in length by ·02 mm. in thickness; in fig. 17 the head-rays are unequal in size, the longest measures ·67 mm. by ·1 mm. in thickness. Similar 'fork' spicules are known from the Chalk of Norfolk (Hinde, Foss.

Sponge Spic. p. 35, pl. ii. figs. 17, 18) and in the recent *Craniella* (*Tethea*) *cranium* (see Mon. Brit. Spong. vol. i. pl. 31. fig. 362 *a*).

*Thenea* (a).—Pl. XIII. fig. 18. Trifid spicule with slender tapering shaft, rounded harpoon-like head, and long, slender, strongly recurved head-rays. The shaft is incomplete, it is .01 mm. in thickness; the head-rays are .128 mm. in length by .01 mm. in thickness. This spicule resembles the trifids in the recent *Thenea* (*Tisiphonia*) *fenestrata*, Osc. Sch., sp., as figured in the 'Challenger' Report (vol. xxv. pl. viii. fig. 3), but the rays are less elongated.

Pl. XIII. figs. 20–24 *a*. Trifid spicules with elongated shafts and simple head-rays, recurved at different degrees. The shafts vary from .03 to .04 mm. in thickness; the head-rays are from .07 to .2 mm. in length. Though the differences in form are slight, yet, judging from recent sponges, these anchor trifid spicules probably represent four or five species. A detached spicule nearly similar to 24 *a* is present in the 'Egeria' dredgings from off the S.W. coast of Australia, at a depth of 2479 fathoms.

The trifid spicules referred to above are very abundant in some portions of the Oamaru material, where they constitute the major portion of the sponge-spicules present, in other portions of the material they are somewhat rare. It is difficult to determine the number of species they may represent, possibly not more than five or six, and equally difficult to refer them to particular genera, since this chiefly depends on the character of the flesh-spicules associated with these skeletal forms. Trifid spicules of the same character as those figured are common wherever sponge-spicules occur in the older rocks, and they are known from the Carboniferous formation upwards, being specially abundant in the Lower and Upper Greensand and in the Upper Chalk of this country. As detached forms, they are numerous in recent dredgings, and they occur from off the S.W. coast of Australia in material from a depth of 3000 fathoms.

#### *Globate Spicules of Geodites, Carter.*

Pl. XIV. figs. 32, 32 *a*. Globates varying from nearly spherical to ellipsoidal in form. An ellipsoidal specimen measures .093 mm. by .04 mm., whilst a nearly spherical individual is .121 mm. by .095 mm. These spicules are fairly abundant in the Oamaru deposit, and they show the same structural details as the globates

of recent species of *Geodia*. It is probable that the differences in size and form may indicate different species. Fig. 32 *a* represents a portion of the surface of a globate, showing the spined heads of the extremely fine acuate spicules of which it is composed.

*Discoidal Spicules of Erylus, Gray.*

*Erylus* (a).—Pl. XIV. fig. 33. Discoidal spicules, elliptical in outline, consisting of an aggregate of hair-like spicules, the summits of which project slightly as small spines. These spicules vary considerably in size: a small specimen is  $\cdot 113$  mm. in length by  $\cdot 076$  mm. in width; whilst a large form, like that figured, is  $\cdot 175$  mm. by  $\cdot 122$  mm. As a rule these spicules are larger than those of the recent *Erylus* (*Stelletta*) *mamillaris*, Osc. Sch., sp., the type of the genus. As fossil these spicules only appear to have been hitherto noticed in the Tertiary radiolarian beds of Barbados, by Mrs. Bury ('Figures of remarkable forms of Polycystines in the Barbados Chalk Deposit,' 1862, pl. xxiii. fig. 2). Detached recent spicules are plentiful in dredgings from off the S.W. coast of Australia in depths of 3000 fathoms.

*Erylus* (b).—Pl. XIV. fig. 34. Extremely thin, circular or elliptical, plane or plano-concave discs or plates, consisting of an aggregate of delicate acuate spicules radiating from a centre. Their surfaces are minutely tuberculate, and their summits rounded. Length  $\cdot 125$  mm., width  $\cdot 105$  mm. These spicules are of the same character as the dermal spicules of *Erylus* (*Stelletta*) *euastrum*, Osc. Sch. (Algier. Spong. 3rd Supp. p. 20, pl. iv. figs. 4 *a*, *b*, *c*, *d*), from off the coast of Algiers.

*Dermal Spicules of unknown Sponge* (Dactylocalycites, Carter; Placolithis, pars, Ehrenberg).

Pl. XIV. figs. 35, 36, 37. Thin siliceous plates, circular, elliptical or suboblong in outline, with a series of flask-shaped, round or elongate perforations just within the margin and a varying number of fine canals either extending across the spicule or radiating from the centre. These canals terminate just within the spicular margin in the spaces between the flask-shaped perforations. They vary in number: in a small specimen (fig. 37) there are only three, which extend across the plate, but do not appear to interconnect where they cross each other; in larger forms there are from 9 to 18 canals, which appear to



radiate from a common centre. In most forms there is one canal in the form of a loop or curve. Not infrequently the canals are so fine as to be only partially visible.

This form of spicule was first described by Mr. Carter from the Upper Greensand of Devonshire, and similar spicules have subsequently been described from the Upper Chalk of Westphalia and Norfolk. They have been figured by Dr. Rüst from the radiolarian Jurassic marls of Ilsede, Hanover ('Palæontographica,' Bd. xxxi. pl. xx. fig. 42); and they also occur in the Tertiary radiolarian earth of Barbados (Bury, 'Polycystines in the Barbados Chalk Deposit,' 1862. pl. vii. figs. 1, 2); and Ehrenberg has figured an imperfect specimen said to have been dredged up from a depth of 13,200 feet in the Indian Ocean between Zanzibar and the Seychelles (Microgeol. Studien, 1873, p. 147, pl. 36. fig. 9), to which he gave the name of *Placolithis lacunosa*. A detached spicule also occurs in the 'Egeria' dredgings off the S.W. coast of Australia at a depth of 3000 fathoms. Hitherto no recent sponge has been discovered with similar spicules. It seems probable that they may be dermal spicules, but they are of quite a different character from the globates of *Geodia* or the discoidal spicules of *Erylus*. The Oamaru forms are smaller, and show a greater variation in outline than those from the Upper Chalk.

*Globostellate Spicules with truncate and lobed rays.*

*Stelletta* (b).—Pl. XIV. figs. 28, 29. Spicules subspherical in outline, consisting of a solid centre or nucleus from which numerous short rays or arms project in different directions. The rays are stout, subcylindrical, with truncate and expanded summits, usually divided into lobes. In each ray there is an axial canal. The spicules appear to have been interlocked together by means of the lobate ends of the rays. Total thickness of spicule .1 mm.; length of rays .025 mm., thickness .018 mm.; width of their summits from .02 to .026 mm. These spicules resemble in character the globostellates of *Stelletta intermedia*, Osc. Sch. (Algier. Spong. 3rd Supp. p. 21, pl. iv. fig. 6), but the arms are shorter and their summits more expanded. According to Schmidt, the rays of these recent spicules intergrow together. Somewhat similar, but much smaller, spicules are also present in *Stelletta reticulata*, Carter (Ann. & Mag. Nat. Hist. s. 5, vol. xi. 1883, p. 352, pl. xiv. fig. 4 e), from off the S. coast of Australia.

Similar spicules likewise occur detached in the 'Egeria' dredgings off the S.W. coast of Australia, at a depth of 3000 fathoms.

*Stelletta* (c).—Pl. XIV. fig. 30. Globostellate with numerous stout conical rays, divided at the apex into two or three small spines or lobes. Diameter of spicule  $\cdot 102$  mm., length of rays  $\cdot 025$  mm., thickness  $\cdot 02$  mm.

Pl. XII. fig. 33. Globostellate with short subcylindrical truncate rays, in number 10 or 12, their summits are bi- or tripartite and spined. Diameter of spicule  $\cdot 015$  mm., length of rays  $\cdot 0055$  mm., thickness  $\cdot 0035$  mm. This form somewhat resembles the globostellates of *S. globostellata*, Carter, referred to above, but it is much smaller. In the character of the rays it is similar to the spicules of *Dictyocylindrus dentatus*, Bowk. (Proc. Zool. Soc. 1873, p. 321, pl. xxix. figs. 3, 4), but these latter possess only 6 rays, and they are moreover much larger forms.

*Stellate and Globostellate Spicules of Stelletta, Osc. Schmidt,  
and allied Genera.*

*Stelletta* (d).—Pl. XIV. figs. 15, 16. Stellate spicules with elongate tapering rays, without any definite centre. Rays smooth, acute or obtusely pointed, from 5 to 10 in number. Length  $\cdot 04$  mm. to  $\cdot 044$  mm., thickness at base  $\cdot 0033$  mm. Similar stellates are present in *Stelletta Wagereri*, Osc. Sch. (Adriat. Spong. p. 46, pl. iv. figs. 3 e, f), and in *Pachymatisma contorta*, Bowk. (Proc. Zool. Soc. 1873, p. 327, pl. xxxi. fig. 10), from off the Fiji Islands.

Pl. XIV. fig. 19. Globostellate with small well-defined centre and about 9 smooth, conical, tapering rays. Diameter of spicule  $\cdot 09$  mm.; of centre  $\cdot 012$  mm. Length of rays  $\cdot 035$  mm. This form differs from the preceding in having a definite centre.

*Globostellate Spicules of Tethya, Lamarch, and other Genera.*

*Tethya* (a).—Pl. XIV. figs. 17, 20, 22, 24. Globostellate spicules with stout, conical, pointed or obtuse rays, from 9 to about 28 in number. The rays are usually smooth, but occasionally minutely tuberculate, with canals in each, which open at the end of the rays. The diameter of the smallest specimen (fig. 22) is  $\cdot 05$  mm., length of rays  $\cdot 0017$  mm. The diameter of the largest is  $\cdot 184$  mm., length of rays  $\cdot 078$  mm. These spicules are fairly numerous in the deposit; they resemble the spicules of

*Tethya*, but as a rule they are larger than the globostellates of *T. lyncurium*, Linn. Spicules of this type are, however, not restricted to *Tethya*, for Carter has figured very similar forms in *Stelletta globostellata*. (Ann. & Mag. Nat. Hist. s. 5, vol. xi. p. 353, pl. xiv. fig. 5 e). Detached spicules of the same form are present in the 'Egeria' dredgings off the S.W. coast of Australia, at a depth of 2479 fathoms.

Pl. XIV. figs. 18, 18 a, 21. Small globostellates having from 8 to 15 rays. The rays are short, subcylindrical, truncate or slightly inflated at the extremities. A small specimen is .011 mm. in diameter, and the rays .004 mm. in length. A large specimen (fig. 21) measures .015 mm. across, and the rays are .0067 mm. in length. Spicules similar to these are present in recent species of *Tethya* associated with the larger spicules described above. In *Geodia tuberculosa*, Bowk. (Proc. Zool. Soc. 1872, p. 626, pl. 46. fig. 8), there is also a form similar to fig. 21, and the same type of spicule is present in other species of *Geodia* and *Stelletta*.

*Pachastrella* (a).—Pl. XIV. figs. 23, 31. Small globostellates in which the rays are reduced to small, conical, pointed or obtuse tubercles projecting slightly above the surface of the centrum. Diameter of spicules .016 mm. to .02 mm. Spicules of this character are present in the recent *Pachastrella exostotica*, Osc. Sch. (Algier. Spong. p. 16, pl. iii. fig. 12), from the Mediterranean, also in *P. geodioides*, Carter (Ann. & Mag. Nat. Hist. s. 4, vol. xviii. 1876, p. 407, pl. xiv. fig. 23 m, o), and in *Cydonium esoaster*, Sollas (Chall. Rep. vol. xxv. p. 225, pl. xxi. fig. 23), from Port Jackson.

#### *Stellate Spicules with Spined Rays.*

Pl. XIV. figs. 25, 26. Comparatively large stellate spicules with from 6 to 10 elongate conical rays, which are furnished with stout spines projecting directly outwards. Axial canals are present in all the rays. Diameter of spicules from .09 mm. to .105 mm., length of rays .04 to .055 mm. Spicules of this character do not appear to have been figured in recent sponges.

Pl. XIV. fig. 27. Small stellate with 8 stout conical rays, which are thickly set with small spines. Diameter of spicule .03 mm. This form is much smaller than the preceding.

## III. LITHISTIDÆ.

*Body-Spicules of Lithistid Sponges.*

*Lydium* (a).—Pl. XIII. figs. 25, 26, 27. Spicules of various forms, with an elongate, subcylindrical main axis, usually curved, which bifurcates or gives off lateral branches, terminating either with transverse convex expansions or obtusely. Surface smooth. Without axial canals. Length of spicules from .42 mm. to .81 mm., thickness of axis .08 mm. to .122 mm. These spicules are of the usual types present in Megamorine sponges, such as, for example, *Doryderma*, Zitt., and other allied fossil genera. They are smaller than the spicules of the recent genus *Lydium*, Osc. Sch. These forms are not very abundant in the Oamaru material. Fossil spicules of the same character are present from the Carboniferous upwards, and they are very common in the Lower and Upper Greensand and the Upper Chalk of the South of England. They appear to be scarce in recent seas.

*Body-Spicules of Vetulina, Osc. Schmidt.*

*Vetulina Oamaruensis*, n. sp.—Pl. XIII. figs. 31, 32, 33. Spicules with definite centres, either rounded or irregular in form, from which a variable number, generally from five to seven, short, thick, straight or curved rays or branches are given off in different directions. The rays are usually simple, but occasionally, as in fig. 33, they are bifurcate, and they terminate in lobed and saddle-shaped expansions. In some spicules the centres have stout conical spines as well as rays, and the rays themselves are sometimes armed with spines. No canals can be distinguished. The spicules range from .14 to .2 mm. in diameter, the centres are about .05 mm. in thickness, the rays are from .051 mm. to .075 mm. in length.

These spicules are of the *Anomocladina* type; they correspond with those of the fossil genus *Mastusia*, Zitt., and the recent *Vetulina*, Osc. Sch., but they indicate a distinct species, which may be termed *Vetulina Oamaruensis*. Sponges with this type of spicule are not uncommon in the Jurassic strata of Germany, they are rare in the Cretaceous rocks, and only one existing species, *V. stalactites*, Osc. Sch. (Mexican Spong. p. 19, pl. i. fig. 1, pl. ii. fig. 9), from off Barbados at 100 fathoms, is as yet known.

*Body-Spicules of Tetracladine Lithistid Sponges.*

Pl. XIII. figs. 28, 29, 30. Spicules with four rays, usually unequal in length, which occasionally subdivide and terminate obtusely. The rays are throughout studded with prominent tubercles. The spicules are from  $\cdot 22$  to  $\cdot 48$  mm. in length, and the principal rays about  $\cdot 066$  mm. in thickness. These spicules are of the same character as those of the Cretaceous genus *Plinthosella*, Zittel, and of the recent *Discodermia*, Bocage.

*Dermal Spicules of Lithistid Sponges.*

*Corallistes* (a).—Pl. XIV. figs. 1, 7. Spicules with short conical shaft and horizontally extended head, consisting of six simple, narrow, obtusely pointed rays, resulting from the bifurcation of the normal three rays. Axial canals extend throughout the rays and open at their ends. Width across head of spicule from  $\cdot 15$  mm. to  $\cdot 36$  mm. Spicules of similar character form the dermal layer in *Heterostinia*, Zitt., and other genera of fossil Cretaceous sponges, and in the recent *Corallistes*, Osc. Sch. (Atlant. Spong. p. 22, pl. iii. fig. 3).

*Corallistes* (b).—Pl. XIV. fig. 6. Spicule with rudimentary shaft and horizontal head of six flattened rays. Diameter of head  $\cdot 5$  mm., length of secondary rays  $\cdot 22$  mm., width  $\cdot 07$  mm. This form is very abundant. Similar spicules occur in *Thamnospongia* and other Cretaceous genera, and in the recent genus *Corallistes*.

*Theonella* (a).—Pl. XIV. fig. 4. Spicule with short shaft and three flattened, horizontally extended head-rays, one simple and rounded at the end, the others slightly furcate. Diameter of spicule  $\cdot 8$  mm., width of rays  $\cdot 125$  mm. No canals are visible in this form. Somewhat similar spicules are present in the recent genus *Theonella*, Gray.

*Discodermia* (a).—Pl. XIV. figs. 2, 3, 5. Spicules with reduced shafts and widely expanded head, in which the normal rays are much subdivided. The rays are smooth, compressed, and end obtusely. An axial canal is present in the shaft, but the canals of the head-rays are quite rudimentary. Diameter of spicules  $\cdot 9$  mm., thickness of primary rays  $\cdot 075$  mm. Spicules of this character are very abundant in the Lower and Upper Greensand and in the Upper Chalk of the South of England, but, as in this Oamaru deposit, they are detached from the sponges to which

they belonged. Smaller spicules of the same type also occur in the recent *Discodermia*, Bocage. Detached spicules, similar to figs. 2 and 3, are present in the 'Egeria' dredgings off the S.W. coast of Australia at a depth of 2479 fathoms.

Pl. XIV. figs. 8, 9, 10, 11. Spicules in which the shafts are much reduced or obsolete, and the heads are of thin siliceous plates with rounded or slightly sinuous outlines. In fig. 8 there is no trace of a shaft nor of axial canals, the border of the plate is smooth and the central portion tuberculate; in fig. 9 the surface, with the exception of the outer border, is dotted over with minute curved dimples, and there are three rudimentary canals; in fig. 11 the canals are much longer than is usually the case with these forms. The spicules are about .15 mm. in diameter. Spicules of this type (with the exception of fig. 11) are present in the dermal layer of the recent *Discodermia*, Bocage.

*Discodermia sinuosa*, Carter.—Pl. XIV. fig. 12. Spicule with short shaft, head-plate flat with margins deeply lacinate and notched. Surface except near margins pitted over with small depressions. Diameter .215 mm. Spicules similar to this form, but somewhat smaller, are present in *Discodermia sinuosa*, Carter, from the Gulf of Manaar (Ann. & Mag. Nat. Hist. s. 5, vol. vii. 1881, p. 372, pl. xviii. fig. 1 c, d).

#### *Dermal Spicules of undetermined Genus.*

Pl. XIV. fig. 13. Spicule with short blunted shaft and horizontally extended head, in which each of the normal three primary rays subdivides into three subequal rays. The rays are subcylindrical, tapering slightly and obtusely ended, and their surfaces are thickly covered with minute spines. Canals extend into each ray and open at their extremities. Diameter across head .091 mm., length of secondary rays .04 mm.

Pl. XIV. fig. 14. Spicule with straight, subcylindrical, obtusely ended shaft, with two primary rays at the summit, each of which divides into three secondary rays. Only the base of the third normal ray appears in this spicule. The rays are spined the same as in the preceding form. Diameter across head .081 mm., length of secondary rays .02 mm., length of shaft .071 mm.

This and the preceding (fig. 13) probably belong to the dermal layer of a Lithistid sponge. In the trifurcate division of the

head-rays these spicules singularly resemble the head-rays of *Samus anonyma*, Gray, as figured by Mr. Carter (Ann. & Mag. Nat. Hist. s. 5, vol. iii. 1879, pl. xxix. fig. 3), but the spicules of this sponge have similar trifurcate rays at both ends of the shaft. A detached spicule resembling fig. 14, but having three normal rays, is figured by Bowerbank as probably belonging to a species of *Dactylocalyx* (Proc. Zool. Soc. 1869, pl. iii. fig. 16), but this is an error, since this genus is hexactinellid.

*Summary of Genera and Species of Tetractinellid and Lithistid Sponges represented in the Oamaru Deposit.*

TETRACTINELLIDÆ.

No. of Species.

- 4 sp. *Corticium*, Osc. Schmidt.
- 1 sp. *Plakina*, F. E. Schulze.
- 2 sp. *Pachastrella*, Osc. Schmidt.
- 1 sp. *Triptolemus*, Sollas.
- 2 sp. *Ditriænella*, g. n.
- 6 sp. *Geodites*, Carter, *Stelletta*, Osc. Schmidt,  
and allied genera.
- 2 sp. *Erylus*, Gray.
- 2 sp. *Tethya*, Lamarck.
- 2 sp. Genus undetermined.

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22 sp.

LITHISTIDÆ.

- 1 sp. *Lyidium*, Osc. Schmidt.
- 1 sp. *Vetulina*, Osc. Schmidt.
- 2 sp. *Corallistes*, Osc. Schmidt.
- 2 sp. *Discodermia*, Bocage.
- 1 sp. Genus undetermined.

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7 sp.

From these lists it appears that there are 22 species and 9 genera of Tetractinellid sponges, and only 7 species and 5 genera of Lithistid sponges in the Oamaru deposit. These numbers can only be considered as approximate, but it is probable that they are under rather than overestimated. Though in the number of species the Tetractinellid sponges fall far short of the Monactinellids, yet in certain portions of the rock their remains far

exceed those of other kinds and constitute the large majority of spicules present. Most of the Tetractinellidæ belong to genera well represented in the Cretaceous and even older rocks, as well as existing at the present day; other genera, such as *Corticium* and *Plakina*, are rare at present and restricted in their distribution. Lithistid sponges are but sparsely represented; two of the three genera recognized, *Lyidium* and *Vetulina*, are rare in the present day, but they belong to families which date back from the Carboniferous epoch. In comparison with the number of species in the Oamaru deposit, it may be mentioned that the 'Challenger' Expedition only obtained 25 species of Tetractinellids from the entire South-Australian Region, in which New Zealand is situate, and but a single species of Lithistid from the same region (Chall. Rep. vol. xxv. p. 387).

#### IV. HEXACTINELLIDÆ, *Osc. Schmidt*.

##### *Acerate Spicule of Hexactinellid Sponge.*

Pl. XV. fig. 1. Spicule straight, fusiform, with a slight sub-central inflation, gradually tapering to either end; surface with minute spines, more numerous near the ends and sparse in the central portion, they project at right angles to the surface. An axial canal traverses the spicule and opens at either end; in the centre there is a distinct nodal swelling. Length of spicule .48 mm., greatest thickness .015 mm. The central inflation of the axial canal indicates that this form belongs to some hexactinellid sponge. Acerate spicules, smaller than this fossil and without spines, are present in the recent *Euplectella nodosa*, Schulze (Chall. Rep. vol. xxi. p. 82, pl. xiv. figs. 3, 4), from near the Bermudas.

##### *Pinule Spicules with Six Rays.*

Pl. XV. fig. 2. Transverse and proximal rays of the spicule subequal, straight or slightly curved, and minutely spined near the ends; the spines on the distal ray thickly set, projecting upwards, the end of the ray extends beyond the spines. Length of the distal ray .137 mm., width (including spines) .029 mm., length of the other rays .069 mm., thickness .01 mm. Pinules of similar form, but larger, are figured by Schulze in *Aulascus Johnstoni* (Chall. Rep. vol. xxi. p. 118, pl. xxii. fig. 3), from the Indian Ocean at a depth of 310 fathoms.



Pl. XV. fig. 3. Spicules of the same character as the preceding, but the distal ray is shorter, the spines on it are less upright and thicker set in the middle portion of the ray. Axial canals traverse all the rays and open at their ends. Length of distal ray  $\cdot 087$  mm., width  $\cdot 035$  mm., the transverse and proximal rays are  $\cdot 07$  mm. in length. Similar but smaller pinules are present in *Caulophacus latus*, Schulze (Chall. Rep. vol. xxi. p. 124, pl. xxiv. fig. 10), from west of the Crozet Islands, in Diatom ooze, at a depth of 1600 fathoms.

Pl. XV. fig. 4. Resembling the preceding, but the transverse and proximal rays are proportionately longer and the spines on the distal ray more bushy, so that it has an ovate outline. Length of distal ray  $\cdot 076$  mm., width  $\cdot 03$  mm., length of the other rays  $\cdot 07$  mm. Pinule spicules of the same character as this are present in *Polyrhhabdus oviformis*, Schulze, and in *Balanites pipetta*, Sch. (Chall. Rep. vol. xxi. pp. 121, 122, pl. xxiii. figs. 4, 13), both from the Antarctic Ocean, in Diatom ooze, at depths of 1950 and 1975 fathoms.

#### *Pinule Spicules with Five Rays.*

Pl. XV. fig. 6. The transverse rays are either horizontal or with a slight upward curvature, their surfaces covered with small spines or tubercles. Distal ray with strong curved and thick spines, the end of the ray extends beyond the spines. Length of distal ray  $\cdot 06$  mm., width  $\cdot 036$  mm., length of transverse rays  $\cdot 022$  mm. Similar but somewhat larger pinules are present in *Hyalonema globus*, Sch. (Chall. Rep. vol. xxi. p. 221, pl. xl. fig. 16), from near the Banda Islands, at a depth of 360 fathoms.

Pl. XV. fig. 7. Pinule with stout, obtusely pointed, transverse rays, thickly set with spines; distal ray short, truncate, with short, straight hooked spines, nearly similar to those of the basal rays. Axial canals well marked. Length of distal ray  $\cdot 059$  mm., thickness  $\cdot 02$  mm., length of transverse rays  $\cdot 06$  mm.

Pl. XV. fig. 5. Pinule with smooth, nearly horizontal, transverse rays and a stout short distal ray which in the upper portion has a group of thickly set curved spines which are all of about equal height, so that the ray appears as if truncate. Length of distal ray  $\cdot 027$  mm., width across spines  $\cdot 018$  mm., length of transverse rays  $\cdot 018$  mm.

Pl. XV. fig. 8. Pinule with smooth, horizontal, transverse rays; distal ray elongate, with stout curved hook-like spines,

extending obliquely upwards. Axial canals very wide in the form figured. Length of distal ray  $\cdot 16$  mm., greatest width  $\cdot 042$  mm., length of transverse rays  $\cdot 06$  mm. In recent sponges the spicule nearest in form to this occurs in *Pheronema Annæ*, Leidy (see Chall. Rep. vol. xxi. p. 239, pl. xlii. fig. 8).

Pl. XV. fig. 9. Pinule with very short, minutely spined, transverse rays, and an elongate tapering distal ray, with some stout conical hooked spines in the lower third of the ray. Length of distal ray  $\cdot 432$  mm., width  $\cdot 048$  mm., length of transverse rays  $\cdot 032$  mm. In the character of the distal ray the pinules of the recent *Hyalonema elegans*, Sch. (Chall. Rep. vol. xxi. p. 223, pl. xxxi. fig. 4), approach this form, but the spines are not restricted to the lower portion of the ray as in this fossil.

Pinule spicules are extremely rare as fossils; hitherto the only forms known are casts in chert from the Jurassic strata of Ilsede, Hanover, described by Dr. Rüst ('Palæontographica,' Bd. xxxi. p. 321, pl. xx. fig. 30), and by Wisniowski, from near Cracow (Jahrb. d. k.-k. geolog. Reichsan. Wien, Bd. xxxviii. 1888, 4 Heft, p. 679, pl. xii. fig. 42).

*Rosette Spicules of Hexactinellid Sponges.*

Pl. XV. fig. 10. Rosette in which some of the primary rays are furcate whilst others are undivided. The rays are smooth, straight or with a slight curve, and acutely pointed. Diameter of spicule  $\cdot 056$  mm., length of secondary rays  $\cdot 021$  mm. Spicules of this type are present in *Caulophacus latus*, Schulze (Chall. Rep. vol. xxi. p. 124, pl. xxiv. fig. 8), already referred to.

Pl. XV. fig. 11. Rosette in which each primary ray gives off four secondary rays. Rays straight, smooth, and acutely pointed. Diameter of spicule  $\cdot 065$  mm., length of secondary rays  $\cdot 027$  mm. These forms are fairly abundant in the Oamaru material. Recent spicules of similar character are present in *Acanthascus cactus*, Sch. (Chall. Rep. vol. xxi. p. 148, pl. 57. fig. 3), from the Japanese Seas.

*Crateromorpha* (a).—Pl. XV. fig. 12. Rosette with numerous rays, about 24 can be counted. The rays are stout, cylindrical, straight or slightly curved, extremities capped with convex discs, surrounded by a fringe of about 12 minute teeth. The surface of the rays is minutely tuberculate. The primary rays of the spicule are so short as to be concealed from view, and the secondary rays appear to radiate direct from a centre. Diameter

across spicule  $\cdot 16$  mm., length of rays  $\cdot 08$  mm., thickness  $\cdot 006$  mm. Many of the rays are now fractured; it is probable that when complete there may have been from 30 to 40. Rosettes somewhat smaller, but with rays of the same character as this fossil, are present in *Crateromorpha tumida*, Schulze (Chall. Rep. vol. xxi. p. 166, pl. 67. fig. 6), from near the Banda Islands, at a depth of 360 fathoms.

*Crateromorpha* (b).—Pl. XV. fig. 13. Rosette of the same character as the preceding, but the rays are much more robust and somewhat shorter in proportion. The convex discs capping the rays are fringed with teeth. The rays appear to start from a thickened globose centre; most of them are now incomplete, but judging by the stumps that remain there would have been from 30 to 40 originally. Length of rays  $\cdot 0875$  mm., thickness at base  $\cdot 0125$  mm., width of capitate disc  $\cdot 025$  mm. The rays of this rosette are much stouter than in any recent spicule of this type.

*Amphidisc Spicules of Hyalonema, Gray, and  
Pheronema, Leidy.*

*Hyalonema* (a).—Pl. XV. fig. 14. Amphidisc with four rays, as if two of the normal forms had been welded together by the shafts. The shafts are elongate, slightly inflated where they are united, and with a few scattered tubercles. The terminal rays, about six in number at each end, are strap-shaped, irregularly curved and twisted, occasionally bifurcate and openly divergent. Diameter of spicule  $\cdot 22$  mm., width across rays  $\cdot 101$  mm., thickness of shaft  $\cdot 009$  mm. This peculiar spicule may be only an abnormal form. Amphidiscs with four rays are, however, present in the recent *Hyalonema tenerum*, Sch. (Chall. Rep. vol. xxi. pl. xxxi. fig. 18).

*Hyalonema* (b).—Pl. XV. fig. 15. Amphidisc with elongate slender shaft, with a subcentral whorl of nodes, the surface with small tubercles. Head-rays about six in number at each end, elongate, lingulate, nearly straight or slightly curved towards the shaft. Length of spicule  $\cdot 189$  mm., width across head-rays  $\cdot 04$  mm., length of rays  $\cdot 065$  mm. In the comparatively small number of the rays this form is distinct from any of the recent amphidiscs figured in the 'Challenger' Report; the nearest approach to it is the large amphidisc in *Hyalonema lusitanicum*, Bocage (see Chall. Rep. vol. xxi. pl. xxviii. fig. 14).

*Hyalonema* (c).—Pl. XV. fig. 16. Amphidisc with slender shaft (covered with stout spines and with a subcentral whorl of spines), and with long, slender, narrow, pointed terminal rays, the ends of which curve slightly outwards. Length of spicule  $\cdot 17$  mm., width across head-rays  $\cdot 045$  mm., length of head-rays  $\cdot 07$  mm., thickness of shaft  $\cdot 005$  mm. The summit-rays are incomplete, the full number being eight at each end. This spicule is of the same character as the large amphidisc in *Hyalonema depressum*, Schulze (Chall. Rept. vol. xxi. pl. xxxv. fig. 4), but it is distinctly smaller.

*Hyalonema* (d).—Pl. XV. fig. 17. Amphidisc with stout, slightly tuberculated shaft, having a median whorl of small nodes. The summit-rays are elongate, spatuloid, pointed at the ends and incurved. There appear to be eight at each end. Summit of spicule flattened, convex. Length of spicule  $\cdot 21$  mm., width across rays  $\cdot 06$  mm., length of head-rays  $\cdot 095$  mm., thickness of shaft  $\cdot 01$  mm.

*Hyalonema* (e).—Pl. XV. fig. 18. Spicule with stout shaft, armed with a few scattered tubercles; the summit rays, about six in number, are stout, short, and openly curved. Length of spicule  $\cdot 31$  mm., width across rays  $\cdot 1$  mm., length of rays  $\cdot 088$  mm., thickness of shaft  $\cdot 02$  mm. This spicule is very similar in character and dimensions to the large amphidisc in *Hyalonema Sieboldi*, Gray (see Chall. Rep. vol. xxi. pl. xxvii. fig. 7), but instead of 8 it has only 6 summit-rays at each end.

*Hyalonema* (f).—Pl. XV. fig. 19. Amphidisc with shaft having some small spines in the central portion; summit-rays, six at each end, ligulate, evenly curved. Length of spicule  $\cdot 09$  mm., width across rays  $\cdot 03$  mm., length of rays  $\cdot 036$  mm., thickness of shaft  $\cdot 0067$  mm. This form is distinctly smaller than those described above.

*Hyalonema* (g).—Pl. XV. fig. 20. Amphidisc with robust shaft, smooth with the exception of a subcentral whorl of small tubercles. The summit-rays, 8 at each end, are curved, spatulate, and elongate, so that there is only a short central interspace between them. Length of spicule  $\cdot 208$  mm., width across rays  $\cdot 09$  mm., length of rays  $\cdot 087$  mm., thickness of shaft  $\cdot 015$  mm.

Pl. XV. fig. 21. Small amphidisc, shaft slender, having a few spines in the central portion; rays delicate, acutely pointed, and evenly curved and elongate, so as nearly to meet in the centre. There appear to have been from 10 to 12 rays at each end in

this spicule when complete, the greater number have been broken off. Length of spicule  $\cdot 1$  mm., width across rays  $\cdot 05$  mm., length of rays  $\cdot 045$  mm., thickness of shaft  $\cdot 005$  mm.

*Hyalonema* (h).—Pl. XV. fig. 26. Small amphidisc, shaft smooth, with slightly convex discs at either end, and 8 or 10 slightly projecting curved rays. Somewhat similar amphidiscs are present in *Hyalonema Thomsoni*, Marshall (see Chall. Rep. vol. xxi. pl. xxxiv. fig. 7). Length of spicule  $\cdot 056$  mm., width across summit  $\cdot 023$  mm., thickness of shaft  $\cdot 003$  mm.

The number and variety of form of the amphidisc spicules referred to above indicate that the hexactinellid sponges to which these flesh-spicules belong were numerous represented in the Oamaru strata. In all, 9 examples are figured, indicating probably 5 or 6 species. The principal recent genera characterized by amphidiscs are *Hyalonema*, Gray, *Pheronema*, Leidy, and *Semperella*, Gray; and it is probable that most of our fossils belong to the first named, though it is certain that one species of *Pheronema* is present. None of the fossil amphidiscs is sufficiently similar to any of the recent to be considered as belonging to the same species. Fossil amphidisc spicules are extremely rare, but an undoubted cast of one has already been described by Wisniewski from Jurassic strata at Cracow (Jahrb. der k.-k. geol. Reichsan. Wien, Band xxxviii. 4 Heft, p. 679, pl. xii. fig. 38).

#### *Scopule Flesh-Spicules of Hexactinellid Sponges.*

*Aphrocallistes* (a).—Pl. XV. fig. 24. Shaft incomplete; the upper portion of the spicule consists of four simple rays, which curve gracefully outwards; they are thickest at their bases and gradually taper upwards, terminating in a small bead-like inflation. The surface of these rays is minutely tuberculate. Length of rays  $\cdot 07$  mm., thickness at base  $\cdot 01$  mm., thickness of shaft  $\cdot 0056$  mm. The scopules in recent hexactinellids nearest to this form occur in *Aphrocallistes Bocagei*, Wright (see Chall. Rep. vol. xxi. pl. lxxxiv. fig. 3), from Japan, and in *Chonelasma hamatum*, Schulze (l. c. p. 323, pl. xci. fig. 4), from the South Pacific, at a depth of 630 fathoms.

Pl. XV. fig. 25. Scopule with cylindrical, slightly curved shaft, the summit of which is inflated and supports four straight simple cylindrical rays, which slightly diverge from one another above. These rays are minutely tuberculate, their summits are

smooth and rounded, but not inflated. The axial canal in the shaft of the spicule is much enlarged, and there is a rounded inflation at the top from which extensions are given off into the rays. Length of shaft (incomplete)  $\cdot 12$  mm., thickness  $\cdot 008$  mm.; length of rays  $\cdot 031$  mm., thickness  $\cdot 0066$  mm. Scopules somewhat similar to this fossil, but with more slender rays, are present in *Hexactinella ventilabrum*, Carter (see Chall. Rep. vol. xxi. pl. xevi. figs. 7, 9).

*Detached Spicules of Hexactinellid Sponges.*

Pl. XV. fig. 27. Spicule with five smooth rays, the proximal ray straight and subcylindrical, whilst the transverse rays are slightly arched and tapering. The rays are traversed throughout by axial canals. Length of proximal ray  $\cdot 235$  mm., of transverse rays  $\cdot 215$  mm.

Pl. XV. fig. 28. Spicule with four stout equal rays in a plane, the rays curved slightly near the ends, which are obtuse and thickly set with minute spines or tubercles, the rest of the spicule smooth. Length of rays  $\cdot 19$  mm., thickness  $\cdot 028$  mm. Similar four-rayed spicules are present in recent species of *Hyalonema*; according to Schulze they occur in the basal pad of the lower portion of the body of the sponge. A similar form to this fossil, but larger, occurs in *Hyalonema tenerum*, Sch. (Chall. Rep. vol. xxi. p. 224, pl. xxxi. fig. 15), from the South Pacific, at a depth of 2550 fathoms.

Pl. XV. fig. 29. Spicule with four unequal rays in a plane; the rays of one axis are elongate, tapering, and acutely ended, whilst those of the other axis are shorter and somewhat obtusely ended. Except in the centre, the rays are set with short conical spines. The centre is slightly inflated. Length of the principal rays  $\cdot 22$  mm., of the shorter  $\cdot 153$  mm., thickness of the rays at the base  $\cdot 028$  mm.

Pl. XV. fig. 30. Spicule with six subequal, slender, slightly curved rays, which taper to an acute point and are covered with small spines. Length of rays  $\cdot 095$  mm., thickness  $\cdot 01$  mm.

*Crateromorpha* (c).—Pl. XV. fig. 31. Spicules with six (?) rays originally, two of them are now only represented by scars; the rays short, thick, and rounded at the ends. The axial canals are very distinctly shown. This form resembles the spicules of the stalk of *Crateromorpha Meyeri*, Gray (see Chall. Rep. vol. xxi. pl. 61. figs. 5, 6), from near Zebu, but it is much larger.

Pl. XV. fig. 32. Spicule probably six-rayed when complete, the rays slender with occasional large spines. Length of rays  $\cdot 047$  mm., thickness  $\cdot 005$  mm. Spicules similar in form but for the most part larger are present in *Semperella claviformis*, Gray (Ann. Mag. Nat. Hist. s. 4, vol. x. 1872, p. 76).

Pl. XV. fig. 33. Two slender five-rayed spicules, spined like the preceding. The spicules are in their natural position with respect to each other.

*Mesh-Spicule of Hexactinellid Sponge.*

Pl. XV. fig. 34. A fragment of spicular mesh of a Dictyonine hexactinellid in which the rays are minutely spined or tuberculate. Thickness of rays  $\cdot 036$  mm., distance from node to node  $\cdot 22$  mm. Small pieces of spicular mesh are common enough in the Oamaru material, but they are always mere fragments, hardly a single square being preserved entire. There is no apparent reason for this minute disintegration of the comparatively strong portion of the sponge-skeleton when one considers the perfect state of preservation of so many of the delicate flesh-spicules.

*Anchoring-Spicules of Hexactinellid Sponges.*

Pl. XV. fig. 22. An imperfect anchoring-spicule showing the distal end of the shaft with four openly curved, acutely pointed rays extending, grapple-like, from it. Both shaft and rays traversed by axial canals. Width across rays 1 mm., length of rays  $\cdot 75$  mm., thickness of shaft  $\cdot 1$  mm. Anchoring-spicules of this type, but usually smaller than the form figured, are present in the recent *Euplectella aspergillum*, Owen (see Chall. Rept. vol. xxi. pl. iii. figs. 22, 23).

*Pheronema* (a).—Pl. XV. fig. 23. Spicule imperfect, consisting of the distal portion of a barbed shaft, which becomes thicker near the end and is harpoon-shaped with two prongs or rays, one of which is partially broken. The rays are smooth and re-curve at an acute angle. The shaft has a wide axial canal, which at the end becomes bulbous, with a minute diverticulum at either side and one above. Length of head-rays  $\cdot 078$  mm., thickness of shaft  $\cdot 017$  mm. This spicule belongs either to the basal tuft or is one of those which project laterally from the surface of the sponge. Recent spicules of this type are much larger than the form figured, such as those of *Pheronema Annæ*, Leidy (see Chall. Rep. pl. xii. fig. 7), and of *P. Grayi*, Sav. Kent (Monthly Micros. Journ. 1870, p. 243, pl. 63. fig. 16), from the coast of Portugal.

*Summary of Genera and Species of Hexactinellid Sponges  
in the Oamaru Deposit.*

HEXACTINELLIDÆ.

No. of Species.

- 5 sp. *Hyalonema*, Gray.
- 1 sp. *Pheronema*, Leidy.
- 1 sp. *Caulophacus*, F. E. Schulze.
- 2 sp. *Crateromorpha* (?), Gray.
- 2 sp. Dictyonine genus (*Aphrocallistes* (?)).

As in the groups previously referred to, so also in this, only an approximate estimate of the genera and species present in the material examined can be obtained from the detached spicules. The species of *Hyalonema* and *Pheronema* have been determined from the amphidisc spicules, and to these genera may be referred the five-rayed pinule spicules (Pl. XV. figs. 5-9). The six-rayed pinules probably belong to one if not more species of *Caulophacus* or an allied genus. The large rosette-spicules represent two species of *Crateromorpha* or an allied genus. The only clue to the dictyonine sponges is furnished by the two forms of scopule flesh-spicules, which belong either to *Aphrocallistes* or an allied genus. The fragments of dictyonine mesh are too minute to give any indication of the genus or species to which they belong. Altogether 11 species and 5 genera appear to be represented.

So far as we are aware, no hexactinellid sponges, whether fossil or recent, have previously been recorded from the New-Zealand region. Even the 'Challenger' Expedition failed to find any in this area, for Prof. Schulze says:—"Neither on the South-east coast of Australia, nor on the voyage from Sydney to New Zealand, was there any sponge booty captured; but to the east of the North Island of New Zealand some Hexactinellid spicules at least were obtained, and near the Kermadec Islands as many as six different species" (Chall. Rept. vol. xxi. p. 432).

*Spicules of unknown relationship.*

Pl. VIII. fig. 32. Spicule almond-shaped, compressed, obtusely pointed at the ends, one side curved, the other nearly straight. The upper and under surfaces smooth, nearly flat. No canals shown. Length .095 mm., width .027 mm. These spicules are not uncommon in the material.



Pl. XIV. fig. 38. Spicule having the form of a delicate thin plate, elliptical in outline, with smooth margins, within this is a narrow band inclosing an ellipse with a slight central constriction; nearly in the longer axis of this figure is a short straight axial canal with a slight bead-like inflation near one end, and on either side of this a simple canal shorter than the central one. The inner band has a finely crimped exterior margin. Length of spicule .105 mm., width .06 mm. This is a rare form and its affinities are very doubtful.

#### GENERAL SUMMARY.

As the result of our investigation of the material from Oamaru, we find that the probable number of genera and species of the different divisions of siliceous sponges, as represented by their detached spicules, is as follows:—

Monactinellid, 70 species and 24 genera.

Tetractinellid, 22   "   "   9   "

Lithistid   ..   7   "   "   5   "

Hexactinellid, 11   "   "   5   "

thus giving a total of 110 species and 43 genera which can be definitely recognized. These numbers in all probability fall far short of the real number present in these beds of siliceous rock, for account must be taken of the fact that only a mere handful of material has been so far examined, and this has been taken at random from the deposit, which, as already stated, is in one place from 40 to 60 feet in thickness. The number of species also would have been increased if an estimate could have been made of those whose skeletons only consist of the common types of larger spicules without distinctive flesh-spicules. These simple types of skeletal spicules, more particularly of Monactinellid sponges, are very abundant in the deposit, but they afford no data of the species or particular genus which they represent, and do not therefore appear in the summary. Nearly every hitherto known form of spicule of siliceous marine sponges, both skeletal and flesh-spicules, is represented in the Oamaru deposit, if we except some of those from Palæozoic strata and a few of recent sponges. Whilst the detached spicules appear for the most part to belong to still existent genera, the species, so far as can be determined from the flesh-spicules, are probably, with a few exceptions, distinct from recent forms.

A particular feature in the sponge-fauna of this Oamaru

deposit is the remarkable preponderance in the number of genera and species of Monactinellid sponges over those of other groups. In the cases of sponge-beds in Cretaceous and Jurassic strata which have been hitherto investigated, the proportions have been reversed, and it might be said that Tetractinellid, Lithistid, and Hexactinellid spicules prevail almost exclusively, whilst those of Monactinellid sponges appear to be absent. This difference in the relative proportions of these groups is probably due to the fact that in the Oamaru deposit the minute and delicate spicules of Monactinellid sponges have been preserved equally as well as the larger and more resistant spicules of the other sponge-groups. Under similar conditions of preservation to those of the sponge-beds of the Cretaceous and older rocks, nearly all the Monactinellid spicules similar to those in the Oamaru deposit would have been rendered unrecognizable; and it is not unreasonable therefore to suppose that the absence of these sponge-spicules in the older rocks is rather due to their having perished in the fossilization, than that they did not co-exist with those other groups whose remains have been in part preserved.

The nearest existing relatives of many of the sponges in this New Zealand Tertiary deposit now inhabit the Indian and Southern Ocean, some are cosmopolitan in distribution, whilst others have as yet only been recognized in the North Atlantic and the Gulf of Mexico.

Another important fact is the association in this Oamaru deposit of sponge-remains, which, judging by their nearest living representatives, inhabit abyssal depths, with others, whose relations now exist in comparatively shallow water. Thus, for example, the deposit contains numerous spicules of the genus *Hyalonema*, recent forms of which, according to the 'Challenger' Report, usually occur in depths below 1000 fathoms, and range down to 3000 fathoms. There are also spicules belonging to such deep-sea Monactinellid genera as *Cladorhiza*, *Chondrocladia*, and *Esperiopsis*, species of which were met with by the 'Challenger' at depths from 1600 to 3000 fathoms. On the other hand there are, in the Oamaru deposit, spicules of such genera as *Myxilla*, which in recent seas are found in water not more than 10 fathoms deep, though some species occur at 600 fathoms, and of other genera both of Monactinellid and Tetractinellid sponges, which now inhabit depths from 10 to 200 fathoms. This association in the same deposit of the remains of what

are apparently deep-sea and shallow-water sponges, may perhaps be explained by the fact that many genera have an extraordinary range of depth—thus *Hyalonema* ranges from 95 to 2900 fathoms, *Esperiopsis* from 30 to 1600 fathoms, *Cladorhiza* from 106 to 3000 fathoms; and it is highly probable that many Monactinellid genera now considered as only existing in shallow and moderately deep water will be found by further investigation to be equally capable of living in the same extreme depths as the more specially abyssal Hexactinellids. This finds confirmation in the ‘Egeria’ dredgings referred to already, which, though from depths of 2479 and 3000 fathoms, are filled with detached acerate, acuate, tibiella, and cylindrical spicules of Monactinellid sponges and flesh-spicules of such genera as *Esperella*, *Acarus*, *Spirastrella*, and *Latrunculia*; some species of which now live at depths of 10–50 fathoms. This occurrence of supposed shallow-water sponges with deep-sea forms has already been commented on by Mr. H. J. Carter, who found in deep-sea dredgings off the Seychelle Islands associated with *Euplectella* the same forms of detached Monactinellid and other spicules which were present in dredgings from the Gulf of Manaar, between Ceylon and the southern extremity of India, at depths of 65 fathoms and under (Ann. & Mag. Nat. Hist. s. 5, vol. v. 1880, p. 439). It can hardly be alleged that the Monactinellid spicules in this and the other cases mentioned have been transported by currents from shallower areas, for we should then find sedimentary matter mingled with them as well.

Taking into account the close similarity in character of the Oamaru deposit with that of the recent diatom ooze in the Southern Ocean, the occurrence in it of the remains of deep-sea sponges, and the fact that similar detached spicules are now abundantly present in deposits from depths of 3000 fathoms off the S.W. of Australia, it may be assumed that these siliceous beds of Oamaru were formed at depths of not less than 1000–1500 fathoms, which is nearly the average depth of the similar deposits in the Southern Ocean, as ascertained by the ‘Challenger’ Expedition.

In conclusion we desire to express our obligations to Mr. H. Morland, Mr. B. W. Priest, Mr. Joseph Clark of Street, who have supplied us with many well-prepared microscopic slides of the material, and more particularly to Captain F. W. Hutton, from whom we received the first consignment of the Oamaru rock.

## EXPLANATION OF THE PLATES\*.

## PLATE VII.

- Figs. 1, 2. Acerate spicules of *Reniera* or *Chalina*.  $\times 200$ .  
 3-8. Acerate spicules of *Reniera* or *Chalina*. Figs. 3, 7, 8  $\times 200$ ; fig. 4  $\times 100$ ; fig. 5  $\times 300$ .  
 9, 10. Elongate acerate spicules.  $\times 100$ .  
 11-13. Abruptly pointed acerate spicules. Figs. 11, 13  $\times 200$ ; fig. 12  $\times 100$ .  
 Fig. 14. Fusiform tibiella spicule.  $\times 200$ .  
 15. Spined acerate of *Halichondria*?  $\times 200$ .  
 16. Spined acerate.  $\times 300$ .  
 17. Verticillately spined acerate.  $\times 200$ .  
 18. Spined acerate of *Halichondria*?  $\times 200$ .  
 Figs. 19, 22. Curved spined acerates.  $\times 200$ .  
 Fig. 20. Spined acerate.  $\times 200$ .  
 21. Annulated acerate spicule.  $\times 200$ .  
 Figs. 23-25. Acerate spicules with central inflation. Fig. 23  $\times 300$ ; figs. 24, 25  $\times 100$ .  
 Fig. 26. Acerate spicule, with spines in centre, of *Alectona*?  $\times 300$ .  
 27. Spined subcylindrical spicule.  $\times 200$ .  
 28. Verticillately spined subcylindrical spicule.  $\times 200$ .  
 29. Verticillately spined subcylindrical.  $\times 200$ .  
 30. Spined cylindrical spicule.  $\times 200$ .  
 Figs. 31-36. Smooth cylindrical spicules of *Reniera*? Figs. 31-35  $\times 200$  fig. 36  $\times 100$ .  
 Fig. 37. Dumb-bell spicule of *Plocamia*.  $\times 200$ .  
 38. Subcylindrical spicule, with spiral ridges, of *Dotona*?  $\times 200$ .  
 39. Spined dumb-bell spicule of *Plocamia*.  $\times 200$ .  
 40. Spined cylindrical spicule.  $\times 200$ .  
 41. Spined acerate spicule.  $\times 200$ .  
 Figs. 42, 43. Spined subcylindrical spicules of *Hymeniacion*?  $\times 100$ .  
 Fig. 44. Spined acerate spicule of *Alectona*.  $\times 200$ .  
 Figs. 45, 47. Smooth cylindrical spicules of *Raspailia*?  $\times 200$ .  
 Fig. 46. Smooth cylindrical spicule of *Reniera*?  $\times 100$ .  
 Figs. 48-50. Smooth fusiform, tibiella spicules of *Myxilla*? Figs. 48, 49  $\times 100$ ; fig. 50  $\times 50$ .  
 Fig. 51. Cylindrical spined spicule of *Plocamia*?  $\times 200$ .  
 52. Vermiculate spicule of *Axinella*.  $\times 200$ .

## PLATE VIII.

- Fig. 1. Tibiella spicule of *Myxilla*?  $\times 200$ .  
 2. Elongate tibiella spicule of *Forcepia*?  $\times 200$ .  
 Figs. 3, 4, 5. Different forms of tibiella spicules. Fig. 3  $\times 100$ ; fig. 4  $\times 200$ ; fig. 5  $\times 300$ .  
 Fig. 6. Tibiella spicules with spined ends of *Iophon*?  $\times 200$ .  
 7. Smooth acute spicule.  $\times 100$ .

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- Figs. 8, 9, 10. Different forms of acuate spicules. Fig. 8  $\times 50$ ; fig. 9  $\times 200$ ; fig. 10  $\times 100$ .
- Fig. 10 *a*. Nearly cylindrical, abruptly pointed, acuate.  $\times 100$ .
- Figs. 11, 12. Smooth acuate spicules of *Myxilla*?  $\times 100$ .
- 13, 14. Smooth curved acuate spicules. Fig. 13  $\times 100$ ; fig. 14  $\times 200$ .
- Fig. 15. Slender elongate acuate.  $\times 200$ .
- Figs. 16–20. Smooth comma-shaped acuates of *Axinella*? Fig. 16  $\times 100$ ; figs. 17, 20  $\times 50$ ; figs. 18, 19  $\times 200$ .
- Fig. 21. Spined acuate spicule.  $\times 200$ .
- Figs. 22, 23. Straight fusiform acuates.  $\times 100$ .
- Fig. 24. Acuate spicule with spined head.  $\times 100$ .
25. Spined straight acuate.  $\times 100$ .
- Figs. 26, 33. Curved spined acuates.  $\times 200$ .
- Fig. 27. Strongly spined acuate spicule.  $\times 200$ .
28. Curved acuate with inflated summit.  $\times 200$ .
29. Upper portion of spinulate spicule with knobbed summit.  $\times 200$ .
30. Acuate spicule with curved summit.  $\times 200$ .
- Figs. 30 *a*, 31. Spined acuate spicules.  $\times 200$ .
- Fig. 32. Almond-shaped spicule.  $\times 200$ .
34. Spined acuate spicule.  $\times 200$ .
- Figs. 35, 36. Elongate spined acuate spicules.  $\times 100$ .
- 37, 37 *a*, 38. Spined pin-like spicules of *Hymenaphia*? Figs. 37, 38  $\times 300$ ; fig. 37 *a*  $\times 600$ .
- 39, 40. Smooth acuates with bulbous shafts.  $\times 100$ .
- Fig. 41. Smooth curved acuate.  $\times 200$ .

PLATE IX.

- Fig. 1. Smooth pin-shaped spicule.  $\times 100$ .
2. Pin-like spicule of *Suberites* (a).  $\times 200$ .
3. Smooth pin-like spicule.  $\times 50$ .
4. Pin-like spicule with spined head.  $\times 200$ .
5. Pin-like, with strongly spined head. *Cribrella* (a).  $\times 200$ .
- Figs. 6, 7, 8. Smooth pin-like spicules of *Spirastrella*? Figs. 6, 8  $\times 100$ ; fig. 7  $\times 50$ .
- 9, 10, 11. Curved pin-like spicules, Figs. 9, 10  $\times 200$ ; fig. 11  $\times 100$ .
- Fig. 12. Fusiform pin-like spicule of *Proteleia* (?).  $\times 200$ .
13. Grapnel spicule of *Acarinus*, Gray.  $\times 200$ .
14. Smooth pin-like spicule.  $\times 100$ .
- Figs. 15–18. Nail-shaped spinulates of *Hymenaphia* (?).  $\times 200$ .
- Fig. 19. Small, smooth, pin-like spicule.  $\times 200$ .
- Figs. 20, 21. Forceps flesh-spicules of *Forcepia Carteri*. Fig. 20  $\times 600$ ; fig. 21  $\times 300$ .
- Fig. 22. Forceps flesh-spicule of *Forcepia Vosmaeri*.  $\times 600$ .
- Figs. 23, 24. Tricurved spicules of *Amphilectus* (?). Fig. 23  $\times 200$ ; fig. 24  $\times 300$ .
- 25–29. Hook-shaped flesh-spicules of *Esperella* and other genera. Fig. 25  $\times 300$ ; figs. 26–29  $\times 200$ .
- Fig. 30. Hook-shaped spicule of *Cladorhiza* (?).  $\times 200$ .

Figs. 31, 32. Hook-shaped flesh-spicules. Fig. 31  $\times 300$ ; fig. 32  $\times 100$ .

33, 34, 37. Trenchant bihamate flesh-spicules of *Hamacantha Johnsoni*?, Bowk.  $\times 200$ .

Fig. 35. Trenchant bihamate flesh-spicule of *Hamacantha Huttoni*.  $\times 200$ .

36. Bihamate spicule of *Hamacantha* (?), sp.  $\times 200$ .

38. Flesh-spicule of *Melonanchora Morlandi*.  $\times 200$ .

39. Equianchorate flesh-spicule of *Melonanchora* (a).  $\times 300$ .

40. Equianchorate spicule of *Desmacidon* (a).  $\times 600$ .

Figs. 41-44. Equianchorate spicules of *Myxilla* ? (a).  $\times 300$ .

Fig. 45. Equianchorate spicule of *Myxilla* (c).  $\times 600$ .

46. Equianchorate flesh-spicule of *Myxilla* (d).  $\times 600$ .

Figs. 47, 47 a. Small equianchorates. Fig. 47  $\times 600$ ; fig. 47 a  $\times 300$ .

Fig. 48. Equianchorate spicule of *Myxilla* (b).  $\times 600$ .

Figs. 49, 50. Lateral views of equianchorate spicules.  $\times 600$ .

51, 52. Front and side view of equianchorate.  $\times 300$ .

Fig. 53. Side view of equianchorate flesh-spicule.  $\times 600$ .

Figs. 54, 55. Equianchorate spicules of *Myxilla*. Fig. 54  $\times 300$ ; fig. 55  $\times 600$ .

#### PLATE X.

Figs. 1, 2. Front and side views of palmate inequianchorate flesh-spicule of *Esperella* (a).  $\times 200$ .

3, 4. Front views of inequianchorates of *Esperella* (b), (c).  $\times 300$ .

5, 6. Slightly oblique views of palmate inequianchorates of *Esperella* (d), (e).  $\times 300$ .

Fig. 7. Oblique view of small inequianchorate of *Esperella* (l).  $\times 300$ .

8. Front view of inequianchorate of *Esperella* (m).  $\times 300$ .

Figs. 9, 10. Side views of small palmate inequianchorates of *Esperella*.  $\times 300$ .

11-14. Different forms of inequianchorate flesh-spicules of *Esperella* (f), (g), (h), (i).  $\times 300$ .

Fig. 15. Side view of palmate inequianchorate of *Esperella* (k).  $\times 300$ .

Figs. 16, 17. Inequianchorate flesh-spicules of *Esperella* (n), (o).  $\times 600$ .

Fig. 18. Side view of palmate inequianchorate of *Esperella* (p).  $\times 600$ .

19. Palmate inequianchorate of *Iophon* (?). Side view  $\times 300$ .

20. Side view of inequianchorate of *Esperella* (q).  $\times 300$ .

21. Equianchorate flesh-spicule of *Myxilla* (e).  $\times 300$ .

22. Side view of equianchorate spicule of *Myxilla* (f).  $\times 600$ .

23. Navicular equianchorate spicule of *Esperiopsis* (a).  $\times 300$ .

24. Equianchorate spicule of *Esperiopsis* (b).  $\times 300$ .

Figs. 25, 26. Side and front views of equianchorate spicules of *Esperiopsis* (c).  $\times 300$ .

27, 28, 29. Side and front views of equianchorate spicules of *Esperiopsis* (d).  $\times 200$ .

Fig. 30. Equianchorate flesh-spicule of *Myxilla* (g). Side view.  $\times 300$ .

31. Equianchorate spicule of *Chondrocladia* (a).  $\times 600$ .

32. Side view of equianchorate of *Chondrocladia* (?).  $\times 600$ .

Figs. 33, 34. Side and front views of equianchorate spicules of *Chondrocladia* (c), (d).  $\times 600$ .

Fig. 35. Inequianchorate flesh-spicule of *Cladorhiza Haasti*.  $\times 600$ .

- Figs. 36, 41. Equianchorate flesh-spicules of *Desmacidon* (b).  $\times 300$ .  
 Fig. 37. Equianchorate (?) spicule of *Chondrocladia* (e).  $\times 300$ .  
 Figs. 38, 39. Front and side views of equianchorate spicules of *Desmacidon* (c).  
 $\times 300$ .  
 Fig. 40. Side view of equianchorate spicule of *Halichondria* (a).  $\times 300$ .  
 Figs. 42, 43. Side views of equianchorate spicules of *Halichondria* (b).  $\times 600$ .  
 Fig. 44. Bipocillate (?) flesh-spicule of *Iophon hybridus*.  $\times 600$ .  
 45. Spined equianchorate spicule.  $\times 300$ . Side view.  
 Figs. 46, 47. Side views of equianchorate flesh-spicules of *Myxilla* (d). Fig. 46  
 $\times 300$ ; fig. 47  $\times 600$ .  
 Fig. 48. Front view of equianchorate spicule of *Myxilla* (h).  $\times 600$ .  
 Figs. 49-52. Front and side views of equianchorate spicules of *Myxilla Dendyi*.  
 $\times 600$ .

## PLATE XI.

- Figs. 1, 2, 3. Anchorate flesh-spicules of *Guitarra Carteri*.  $\times 200$ .—Fig. 1 is a front view showing transverse striæ; fig. 2 shows the axial canal extending from one tubercle to the other; fig. 3 shows the outlines of the spicular shaft.  
 4-7. Anchorate flesh-spicules of *Guitarra intermedia*.—Fig. 4 is a specimen in which the front palms are absent,  $\times 200$ . Fig. 5 is an oblique view showing the anterior palms; fig. 6 is a side view,  $\times 200$ ; fig. 7 is a side view of a much smaller specimen in which there are indications of canals in the anterior palms,  $\times 600$ .  
 8, 9. Equianchorate spicules of *Pseudohalichondria deformis*.  $\times 600$ .  
 Fig. 10. Equianchorate spicule of *Pseudohalichondria* (a).  $\times 600$ .  
 Figs. 11, 14. Spined anchorate spicules of *Pseudohalichondria* (b).  $\times 600$ .  
 Side view.  
 12, 13. Oblique and side views of equianchorate spicules of *Pseudohalichondria Oamaruensis*.  $\times 600$ .  
 Fig. 15. Sceptrella flesh-spicule of *Latrunculia* (a).  $\times 300$ .  
 16. Sceptrella spicule of *Latrunculia* (b).  $\times 300$ .  
 Figs. 17-23. Different forms of sceptrella spicules of *Latrunculia* (c), (d), (e), (f), (g), (h), (i). Figs. 17, 21, 22, 23  $\times 300$ ; figs. 18, 19, 20  $\times 600$ .  
 24-28. Different forms of sceptrella flesh-spicules of *Latrunculia* (o), (p), (q), (r). Figs. 24-27  $\times 600$ ; fig. 28  $\times 300$ .  
 29, 30, 31. Modified sceptrella spicules of *Latrunculia* (s).  $\times 600$ .  
 Fig. 32. Sceptrella spicule of *Latrunculia obtusa*.  $\times 300$ .  
 33. Sceptrella flesh-spicule of *Latrunculia* (t).  $\times 600$ .  
 Figs. 34, 35. Elongate sceptrella spicules of *Latrunculia Oamaruensis*.  $\times 300$ .  
 36-39. Different forms of sceptrella spicules of *Latrunculia* (k), (l), (m), (n).  $\times 300$ .  
 Fig. 40. One of the whorls of a sceptrella, seen from above, showing the shaft and axial canal in section.  $\times 600$ .  
 Figs. 41, 42. Nodose flesh-spicules of *Thoosa Hancocki*.  $\times 600$ .  
 Fig. 43. Nodose flesh-spicule of *Thoosa Hancocki* (?).  $\times 600$ .  
 44. Sceptrelliform flesh-spicule of *Alectona*.  $\times 600$ .  
 45. Modified sceptrella of *Latrunculia* (u).  $\times 600$ .

## PLATE XII.

- Figs. 1, 2. Two forms of flask-shaped flesh-spicules of *Latrunculia* (v).  $\times 600$ .  
 Fig. 3. Spined barrel-shaped flesh-spicule of *Thoosa* (a).  $\times 600$ .  
 Figs. 4, 5. Spirular flesh-spicules of *Spirastrella* (a).  $\times 600$ .  
 6, 7. Spirular flesh-spicules of *Spirastrella* (b), (c).  $\times 600$ .  
 8, 8a. Spirular flesh-spicules of *Pronax* (a).  $\times 300$ .  
 Fig. 9. Spined spirular spicule of *Pronax* (b).  $\times 600$ .  
 10. Candelabrum spicule of *Corticium* with inflated head-rays.  $\times 600$ .  
 11. Smaller candelabrum with similar head-rays to fig. 10.  $\times 600$ .  
 12. Candelabrum spicule of *Corticium* (b) with obtusely-pointed head-rays.  $\times 600$ .  
 Figs. 13, 13a, 14, 15. Candelabra spicules of *Corticium* (b) with mitre-like summits and varying number of basal rays.  $\times 600$ .  
 Fig. 16. Candelabrum with quadripartite head-rays of *Corticium* (c).  $\times 600$ .  
 17. Candelabrum with simple head-rays of *Corticium* (d).  $\times 600$ .  
 Figs. 18, 19. Candelabra spicules, with extended basal rays, of *Corticium* (e).  $\times 600$ .  
 20, 21. Candelabra spicules of *Plakina australis*.  $\times 600$ .  
 22, 23, 24. Modified stellate spicules of *Corticium* (?). Figs. 22, 23  $\times 600$ ; fig. 24  $\times 300$ .  
 25, 26, 27. Modified small calthrops spicules of *Corticium*. Figs. 25, 27  $\times 300$ ; fig. 26  $\times 600$ .  
 28-32. Modified calthrops (?) spicules of *Corticium* (?). Figs. 28, 30  $\times 300$ ; figs. 29, 31, 32  $\times 600$ .  
 Fig. 33. Small globostellate, with spined truncate rays, of *Stelletta*?  $\times 600$ .  
 Figs. 34, 35. Trifid spicules of *Ditriænella Oamaruensis*, n. g. et sp.  $\times 200$ .  
 Fig. 36. Trifid spicule of *Ditriænella* (a).  $\times 600$ .  
 37. Spined calthrops spicule of undetermined sponge.  $\times 600$ .

## PLATE XIII.

- Figs. 1, 2. Fusiform acerate spicules of *Geodites* and *Stelletta*.  $\times 20$ .  
 3, 4, 5. Trifid skeletal spicules of *Geodites* (a).  $\times 20$ .  
 6, 7, 8. Different forms of trifid spicules of *Geodites* (b). Fig. 6  $\times 20$ ; figs. 7, 8  $\times 40$ .  
 9, 10. Trifid skeletal spicules of *Stelletta* (a). Fig. 9  $\times 20$ ; fig. 10  $\times 40$ .  
 11-15. Different forms of trifid spicules of *Geodites* or *Stelletta*. Fig. 11  $\times 50$ ; figs. 12-15  $\times 20$ .  
 16, 17. Forked trifid spicules. Fig. 16  $\times 50$ ; fig. 17  $\times 20$ .  
 Fig. 18. Anchor trifid spicule of *Thenia* (a).  $\times 100$ .  
 19. Anchor trifid spicule of *Geodites* (a).  $\times 20$ .  
 Figs. 20-24a. Different forms of anchor trifid spicules. Fig. 20  $\times 20$ ; fig. 21  $\times 40$ ; fig. 22  $\times 100$ ; figs. 23, 24  $\times 50$ ; fig. 24a  $\times 200$ .  
 25, 26, 27. Different forms of lithistid skeletal spicules of *Lyidium* (a).  $\times 40$ .



- Figs. 28, 29, 30. Different forms of skeletal spicules of *Tetracladine* lithistids.  $\times 50$ .  
 31, 32, 33. Different forms of skeletal spicules of *Anomaccladine* lithistid, *Vetulina Oamaruensis*.  $\times 200$ .  
 Fig. 34. Modified trifid spicule of *Triptolemus australis*.  $\times 40$ .  
 Figs. 35–40. Different forms of calthrops spicules of *Pachastrella*. Figs. 36, 38,  $40 \times 40$ ; fig. 35  $\times 100$ ; figs. 37, 39  $\times 200$ .

PLATE XIV.

- Figs. 1, 7. Trifid spicules of the dermal layer of lithistid sponges. *Corallistes* (a). Fig. 1  $\times 200$ ; fig. 7  $\times 50$ .  
 2, 3, 5. Modified trifid spicules of the dermal layer of *Discodermia* (a).  $\times 40$ .  
 Fig. 4. Modified trifid spicule of the dermal layer of *Theonella* (a).  $\times 40$ .  
 6. Dermal spicule of *Corallistes* (?).  $\times 40$ .  
 Figs. 8–11. Different forms of lithistid dermal spicules of *Discodermia*.  $\times 100$ .  
 Fig. 12. Dermal spicule of *Discodermia sinuosa*.  $\times 100$ .  
 Figs. 13, 14. Modified dermal spicules in which each of the head-rays is trifurcate, genus undetermined.  $\times 200$ .  
 15, 16. Stellate spicules of *Stelletta* (d).  $\times 300$ .  
 17, 20, 22, 24. Globostellate spicules of *Tethya* (a). Figs. 17, 20  $\times 100$ ; figs. 22, 24  $\times 300$ .  
 18, 18 a, 21. Small globostellate spicules of *Geodites* (?).  $\times 600$ .  
 Fig. 19. Globostellate spicule.  $\times 200$ .  
 Figs. 23, 31. Small globostellates of *Pachastrella* (a).  $\times 600$ .  
 25, 26, 27. Stellate spicules with spined rays. Figs. 25, 26  $\times 200$ ; fig. 27  $\times 600$ .  
 28, 29, 30. Globostellate spicules with truncate and spined rays of *Stelletta* (b).  $\times 200$ .  
 32, 32 a. Globate spicule of *Geodites*.  $\times 200$ .—Fig. 32 a. A portion of the surface of fig. 32, still more enlarged, showing the spined heads of its minute component spicules.  $\times 600$ .  
 33, 34. Two forms of discoidal spicules of *Erylus* (a), (b).  $\times 200$ .  
 35, 36, 37. Dermal spicules of unknown sponge, *Dactylocalycites*, Carter.  $\times 200$ .  
 Fig. 38. Dermal (?) spicule of unknown sponge.  $\times 200$ .

PLATE XV.

- Fig. 1. Spined acerate spicule of Hexactinellid.  $\times 200$ .  
 Figs. 2, 3, 4. Different forms of six-rayed pinule spicules of *Caulophacus* and allied genera.  $\times 200$ .  
 Fig. 5. Short truncate pinule with five rays.  $\times 600$ .  
 Figs. 6, 7, 8, 9. Different forms of five-rayed pinule spicules of *Hyalonema* and allied genera. Figs. 6, 7, 8  $\times 200$ ; fig. 9  $\times 100$ .  
 10, 11. Two forms of rosette spicules of Hexactinellid.  $\times 300$ .

- Figs. 12, 13. Two forms of rosette spicules of *Crateromorpha* (a), (b).  $\times 200$ .  
Many of the rays in these spicules are imperfect, having been broken away.
- Fig. 14. Amphidisc spicule of *Hyalonema* (a) with four rays.  $\times 100$ .
- Figs. 15, 16. Two forms of amphidisc spicules of *Hyalonema* (b), (c).  $\times 200$ .
- Fig. 17. Amphidisc spicule with eight elongate rays at each end, *Hyalonema* (d).  $\times 200$ .
- Figs. 18, 19, 20. Different forms of amphidisc spicules of *Hyalonema* (e), (f), (g). Figs. 18, 20  $\times 100$ ; fig. 19  $\times 300$ .
- Figs. 21, 26. Small amphidisc spicules. Fig. 21  $\times 200$ ; fig. 26  $\times 300$ .
- Fig. 22. Distal end of anchoring-spicule of Hexactinellid.  $\times 20$ .
23. Distal end of anchoring-spicule of *Pheronema* (a) with barbed shaft and harpoon-like head.  $\times 200$ .
24. Upper portion of scopule spicule of *Aphrocallistes* (a).  $\times 300$ .
25. Portion of shaft and rays of scopule spicule.  $\times 300$ .
27. Detached five-rayed spicule of Hexactinellid.  $\times 200$ .
28. Detached four-rayed spicule of *Hyalonema*.  $\times 100$ .
29. Spined four-rayed spicule.  $\times 100$ .
30. Slender spined six-rayed spicule.  $\times 200$ .
31. Six-rayed spicule of *Crateromorpha* (c).  $\times 100$ .
32. Slender six-rayed spicule with prominent spines.  $\times 200$ .
33. Slender five(?) -rayed spicules in their natural position with respect to each other.  $\times 200$ .
34. Fragment of spicular mesh of dictyonine Hexactinellid.  $\times 200$ .
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On the Occurrence of two Species of *Cumacea* in New Zealand.

By GEORGE M. THOMSON, F.L.S.

[Read 17th December, 1891.]

(PLATES XVI.-XVIII.)

HITHERTO no species of Crustacea belonging to the suborder Cumacea have been described from New-Zealand waters. This might be considered somewhat remarkable, considering the attention which has been paid to the whole group, until it is remembered that nearly all the collections hitherto made have been gathered on the coast-line, or from shallow waters within sheltered bays or inlets. My own dredgings, from the Bay of Islands in the north to the inlets of Stewart Island in the south, have never been taken from a greater depth than 15 fathoms. During the 'Challenger' Expedition the dredge was used at two stations, No. 168, off Cape Turnagain, in 1100 fathoms, and No. 169, off East Cape, in 700 fathoms. At both of these stations various species of Crustacea were obtained, but no Cumacea. Even in Australian waters no species of this group were recorded until the publication in 1887 of the Report on the Cumacea of the 'Challenger' Expedition by Prof. G. O. Sars. This Report contains the description of three species of *Cyclaspis*, one from the entrance to Port Phillip in 38 fathoms, and two from Flinders Passage, between Australia and New Guinea, both taken at a depth of 7 fathoms. So far as I know, these are the only Cumaceans described from Australian seas.

In December, 1883, I had a couple of days' dredging in the Bay of Islands, in the northern portion of this colony, but had no opportunity for a long time of working out any of the material collected. On sorting out, however, I found that a few specimens of Cumaceans were among my finds, belonging to the two genera *Cyclaspis* and *Diastylis*. In June of last year (1890) I did a little surface-netting at night in Otago (Dunedin) Harbour, and obtained a few immature specimens of the same species of *Cyclaspis*. No doubt, when more systematic examination of the bottom of our seas and of those round Australia is made with the dredge, other forms and in greater abundance of individuals will be brought to light.

Both forms described in this paper appear to me to be quite distinct from any other species of the genera hitherto known. A feature in which they differ from all species yet described, excepting *Cyclaspis pusilla*, Sars, is the total absence of spines, or other epidermal growths, and of sculpturing on the carapace.

CYCLASPIS LEVIS, n. sp. (Plates XVI. & XVII. figs. 1-26).

*Specific Characters*.—Carapace somewhat laterally compressed, keeled above and slightly gibbous, smooth, destitute of ridges or sculpturing. Ocular lobe hardly visible. Eye not made out (wanting?). Body slender, tapering gradually to the tail; dorsal ridge distinct, lateral ridges almost wanting. First pair of legs with basal joint elongated and produced into a long acute appendage; remaining five joints about as long as the base; last joint with four spines. Second pair of legs as long as or longer than the third; terminal joint armed with six serrated spines. Uropoda with the branches subequal and rather shorter than the scapes, with a fringe of setæ along the inner edge.

Length of largest specimen 8 millim.

Seen from above, the form of the body is rather slender, and tapers gradually and uniformly from the carapace to the tail. Looked at from the side, the carapace is considerably dilated, and is evenly rounded on its upper surface. The "pseudo-rostral projection" (of Sars) is short, pointed upwards, and sub-obtuse. The length of the carapace is about one fourth that of the whole animal, exclusive of the uropoda. The whole surface of the body is remarkably free from ridges or prominences. The integument is marked throughout by small rounded scale-like thickenings. The colour (in spirit-specimens) is nearly white, without any pigment-spots.

The four exposed segments of the thorax behind the carapace are somewhat broader than the caudal segments, and are connected with each other by flexible membranous spaces; the epimera are rounded both anteriorly and posteriorly. The abdominal segments are longer than the thoracic, and are nearly uniform in length, except the penultimate, which is the longest. The relative length of all the body-segments on the dorsal line from the front of the carapace to the end of the tail is as follows:—

Carapace.	Four visible thoracic segments.				Six abdominal segments.					
	39	4,	5,	11,	8	14,	14,	15,	14,	20, 13

As in *C. australis* each segment is furnished on its antero-lateral margin with an acute knob-like process, which fits into and hinges with a notch on the posterior margin of the preceding segment.

The *antennulæ* (Pl. XVI. fig. 4 *a*<sup>1</sup>) bear a general resemblance to the same organs in *C. australis*, having a 3-jointed peduncle, of which the basal joint is large and broad in comparison with the two which succeed it. The flagellum also is 2-jointed, and bears at its extremity two long setæ. Of the second flagellum, which occurs in a rudimentary form in other species of the genus, I have failed to find any trace in this species.

The *antennæ* (Pl. XVI. fig. 4 *a*<sup>2</sup>) in the female are rudimentary, consisting of a broad base bearing on its inner face two plumose setæ, and—at the extremity of its distal part which projects almost at right angles from its proximal end—tapering to a small conical joint tipped with three minute setæ. In the male (fig. 5) the antennæ are furnished with a basal joint, with which the rest of the organ articulates at right angles. The distal portion of the peduncle consists of two joints, of which the second is nearly three times as long as the first, and bears a very long multi-articulate flagellum. In the specimen figured, in which it is evident that a portion has been broken off, the flagellum is about four times as long as the base, and is divided into 45 articulations, each tipped with a few minute setæ. There is nothing of the vermiform appearance which Sars describes and figures as characterizing the antennæ of the young male of *C. australis* examined by him.

The *mandibles* (fig. 6) are extremely brittle, and hence are difficult to dissect without breaking. The right mandible has its anterior or cutting-branch ending in a single strongly indurated tooth, behind which, on the inner margin, is a comb-like row of curved setose spines. The left mandible has the same branch ending in two strong teeth or projections, of which the outer and larger is itself formed of four blunt teeth. In each mandible the molar tubercle stands nearly at a right angle to the cutting-branch.

The *first maxillæ* resemble the same organs in *C. australis*, having two masticatory lobes, of which the outer is the broader, and is armed with about eight spines, while the slender inner one has four curved spines. The palp is long and very narrow, and bears two long extremely slender setæ; it projects backwards from the base of the outer masticatory lobe.

The *second maxillæ* are two-jointed, the basal portion being the larger. Its outer margin is nearly straight (not expanded as in *C. australis*), while its inner margin forms a rounded cutting-edge, fringed with numerous setæ. The second segment is also fringed with setæ, which are so numerous as to make it difficult to distinguish the plate-like palp, which is also setose on its margin.

The *maxillipeds* have their outer portion curved inwards, so that each appears like two plates standing alongside of and at right angles to one another. The general appearance of these organs is very similar to those of *C. australis*. The basal portion bears on its inner edge *seven* longish setæ, of which the anterior four are more or less plumose. The palp (Pl. XVII. fig. 11) is 4-jointed, the third joint bearing on its inner edge a row of stout bidentate teeth. The narrow penultimate joint bears two plumose spines at its outer angle, while the minute terminal joint ends in three short spines. The *branchial apparatus* is difficult to dissect out on account of its extremely fragile nature; it resembles the corresponding organ in *C. australis*, but the branchiæ themselves are longer than are represented in the figures of that species in the 'Challenger' Cumacea.

The *first gnathopods* (fig. 12) are 5-jointed. The basal joint is about twice as long as all the remaining four; it is elongated in shape, its length being four times as much as its greatest breadth; near the extremity of its outer edge it bears a row of (about eight) slender spines, and on its extremity two plumose setæ, one on each side, and a few slender spines. The second joint is destitute of setæ. The third has one plumose seta on its outer extremity, and a row of about seven on its inner margin. The penultimate joint has three spines on its inner extremity, and one plumose seta on its outer. The last joint is small and narrow, and bears one strong and several slender spines at its extremity.

The *second gnathopods* (figs. 13 and 14) are more than twice as large as those of the first pair. The basos is more than twice as

long as those succeeding it; it is elongated and produced on its outer margin into a long acute lamella, which bears a row of spines on its inner edge. The ischium bears a row of short plumose setæ on its inner margin, and has its outer extremity produced into a blunt curved lamella which ends in a single plumose seta. The meros is very short, and bears only one or two setæ. The two remaining joints are bent almost back on the meros (fig. 14), so that their structure can hardly be made out until they are dislocated: the propodos ends in a strong spine and two or three short setæ. The exopodite of this limb is about half the length of the gnathopod, and, exclusive of the base, is 7-jointed; each of the joints bears two long beautifully plumose setæ.

The *first pair of legs* (fig. 15) exhibit a modification of the structure which characterizes the three pairs of limbs anterior to them. The prolongation of the basos is very slender and acute; it shows the coarse granular structure described by Sars as occurring in *C. australis*, and is destitute of setæ or spines, as indeed are all the joints except the last. The ischium is not produced as it is in the second gnathopods, while the remaining joints are elongated and slender; the last bears a few setæ at its extremity.

The *four pairs of ambulatory legs* diminish gradually in size posteriorly, and are not very dissimilar in form. In the specimen dissected the relative lengths were 1 mm., 0·93 mm., 0·87 mm., and 0·71 mm. In the first of these (*second pair of legs*) the basos is long and narrow, the ischium is very short and bears a long plumose spine at its extremity; the meros, which is somewhat longer, also bears a plumose spine; the carpos has three spines at its extremity, each of which is finely pectinated or toothed along one of its margins (fig. 16); the dactylos is nearly twice as long as the propodos, and ends in three strong spines.

The *pleopoda* are wanting in the females, as usual in the Cumacea. In the males five pairs are present, and are very similar in form, the last pair being somewhat the smallest. Each pair consists of a strong basal joint and two branches (figs. 20-24). The basal joint is about three times as long as it is broad, and bears on its inner edge, near the middle, a short row of spines which are curiously serrated at their apex. The outer branch is 2-jointed, the last joint being oval in shape and fringed round its end with long setæ.

The inner branch is a 1-jointed plate-like lamella, nearly as long as the outer, and fringed with long setæ on the inner margin and round the extremity.

The *uropoda* (fig. 25) are twice as long as the last abdominal segment and are 2-branched; on their inner edge they bear a line of fine setæ. The outer branch of each is 2-jointed, but only indistinctly so; the first joint is very short; the second is long, acutely lanceolate in form, and bears a row of fine setæ along the inner margin. The inner branch is 1-jointed, shorter than the outer, acutely tapering in form, and bears on its inner edge a row of setæ which gradually pass into short spines.

*Habitat.* Bay of Islands, taken with the dredge in 8 fathoms; Otago Harbour (Dunedin), a few very immature specimens taken with a surface-net.

*DIASTYLIS NEO-ZEALANICA*, n. sp. (Plate XVIII. figs. 1-11).

*Specific Characters.* (Female.)—Carapace slightly compressed, scarcely narrowed behind, arched above, about twice as long as rest of body; surface quite smooth, destitute of spines; pseudo-rostral projection conical, somewhat arched above. No eye? Telson conical, spinous on both sides. Uropoda with the scape about twice as long as telson, slender; branches subequal, about half as long as scape, 3-jointed; inner branch with the joints subequal, outer with the terminal joint exceeding the two proximal.

Length of largest specimen 8 millim.

The carapace is not quite twice as long as the exposed part of the trunk; its width is only slightly diminished in the posterior portion, while the first exposed joints of the hind part of the body are very narrow. It is somewhat distinctly 6-jointed, and when seen from the side (Pl. XVIII. fig. 1) it has, especially in the front portion, a sinuous outline, while the pseudo-rostral projection is somewhat arched above and produced into a short conical beak. In the dorsal aspect (fig. 2) the carapace is seen to be acutely pointed, the rostrum appearing like a cone.

The tail is somewhat longer than the anterior part of the body, and is laterally flattened; each segment is produced backwards on the lateral line into a blunt projection. The relative lengths of these segments in the dorsal line are as follows:—



1.	2.	3.	4.	5.	6.
11	11	14	21	29	21

The integument is smooth over the whole body, and exhibits a distinct reticulation under the microscope (Pl. XVIII. fig. 3). Its colour (in my spirit-specimens) is a uniform white without any pigment-spots.

Owing to the imperfect preservation of the only adult specimen, the antennal and oral parts could not be satisfactorily made out. The *mandibles* are of normal form, that of the right side having the molar process more strongly toothed than in the left.

The *first gnathopods* (fig. 4) are slender, and have the basos nearly smooth, except the extremity of the outer edge, which bears a few short bristles, and the anterior margin, which has a few long plumose setæ. The remaining five joints are all more or less furnished with plumose setæ. The ischium and carpos bear each on their outer extremity a very long plumose seta.

The *second gnathopods* (fig. 5) are half as long again as the preceding pair, and more than twice as broad. The basos is long and broad, and bears on its inner edge a row of strong bristles. At its outer extremity it is furnished with a double row of long plumose setæ, which extend nearly as far as the end of the limb. The exopodite (with its setæ) does not quite reach to the end of the basos; it is 7-jointed, and ends in numerous long setæ.

The *legs of the first pair* (fig. 6) are very long, exceeding the carapace, and about equalling the length of the whole cephalothoracic portion of the body. The basos is long and curved outwards, smooth on the upper edge, which is terminated by two long setæ, and furnished on the lower edge with a row of simple setæ; its anterior margin bears a single tooth. The ischium and meros are very short, subequal, and nearly smooth. The three remaining joints are very slender and elongated; the carpos is quite destitute of setæ, while the two following joints have only a few long slender simple setæ on their lower margin. The exopodite only reaches with the end of its setæ a little past the extremity of the basos. Its basal joint, as well as the basos of the limb itself, appears under a moderate power of the microscope as if covered with finely imbricating scales. The same markings appear on the next two pairs of limbs.

The *legs of the second pair* are about two thirds as long as those preceding them, and are somewhat similarly formed; but the setæ on the inner margin of the basos are all beautifully plumose. The exopodite is also relatively much longer, its setæ reaching to the extremity of the carpal joint. The *legs of the third pair* are shorter but relatively stouter than the second pair, but, as usual, have no exopodite. While the ischium is very short, the carpos is about as long as the basos. The last two joints are very short, and are nearly hidden by the long setæ at the end of the carpos. The *legs of the fourth pair* (fig. 9) have their joints diminishing in length towards the extremity; all the joints carry numerous setæ, those on the basos being finely plumose.

The conical *telson* (fig. 11) is about as long as the last joint of the hind body, and bears spines on both sides on its distal half, the two terminal spines being hardly longer than those at the sides. The scape of the uropoda and its inner branches are uniformly spinous on their inner margins; the outer branch on its outer margin. Each terminates in a rather long spine.

*Habitat.* Bay of Islands; one mature female and three small immature females (two of them very minute) were taken by the dredge in 8 fathoms.

## EXPLANATION OF THE PLATES.

### PLATE XVI.

#### *Cyclaspis levis.*

- Fig. 1. Male, lateral view.  
 2. The same, dorsal view.  
 3. Portion of integument (highly magnified).  
 4. Portion of antennary segment of female:  $a^1$ , antennule;  $a^2$ , rudimentary antennæ.  
 5. Antenna of male.  
 6. Mandible:  $a^1$ , right side;  $a^2$ , left side.

### PLATE XVII.

#### *Cyclaspis levis.*

- Fig. 7. Maxilla, first pair.  $\times 125$ .  
 8. Maxilla, second pair.  $\times 125$ .  
 9. } Maxillipeds.  $\times 125$ .  
 10. }

PLATE XVII. (*continued*).

Fig. 11. Palp of maxilliped.

- |                                    |   |
|------------------------------------|---|
| 12. Gnathopod of the first pair.   | } In these figures the small letters<br>represent the following joints:—<br><i>b</i> , basos; <i>i</i> , ischium; <i>m</i> , meros;<br><i>c</i> , carpos; <i>p</i> , propodos; <i>d</i> , dactylos;<br>and <i>ex</i> , exopodite. |
| 13. Gnathopod of the second pair.  |   |
| 14. Extremity of second gnathopod. |   |
| 15. Leg of the first pair.         |   |
| 16. Leg of the second pair.        |   |
| 17. Leg of third pair.             | ×56.  |
| 18. Leg of fourth pair.            | ×56.  |
| 19. Leg of fifth pair.             | ×56.  |
| 20. Pleopod of the first pair.     | ×56.  |
| 21. Pleopod of the second pair.    | ×56.  |
| 22. Pleopod of the third pair.     | ×56.  |
| 23. Pleopod of the fourth pair.    | ×56.  |
| 24. Pleopod of the fifth pair.     | ×56.  |
| 25. Uropoda.                       | ×56.  |
| 26. Antennulæ.                     | ×125.   |

## PLATE XVIII.

*Diastylis neo-zealanica*, ad. ♀.

Fig. 1. Animal in lateral view.

2. Carapace and front part of body, from above.
  3. Portion of integument (highly magnified).
  4. Gnathopod of the first pair. ×43.
  5. Gnathopod of the second pair. ×43.
  6. Leg of the first pair. ×43.
  7. Leg of the second pair. ×43.
  8. Leg of the third pair. ×43.
  9. Leg of the fourth pair. ×43.
  10. Last segment of body, with telson and uropoda. ×18.
  11. The same (highly magnified).
-

Observations on the Gland-like Bodies in the *Bryozoa*.

By ARTHUR WM. WATERS, F.L.S., F.G.S.

[Read 7th April, 1892.]

(PLATE XIX.)

IN my Supplementary Report on the *Polyzoa* collected by H.M.S. 'Challenger'\*, I referred (p. 27) to certain gland-like bodies† occurring in a large number of species, and also to sacs difficult to explain in the avicularian chamber of *Lepralia margaritifera*, Quoy and Gaimard. It happened that the 'Challenger' material of the species in which these structures were noticed was not at all satisfactory for their exact study, nor would the time allowed me for my work have permitted of many preparations. I have therefore since cut sections of all my available species, and as several new points have turned up it seems best now to publish my results even though they cannot be looked upon as complete, for I have not yet been able to trace the early stages of these structures; on the other hand, there seems reason for considering that the suboral and avicularian glands must be considered as homologous.

The sections were mostly cut from specimens obtained from Naples and preserved in spirit many years ago, but a few were recently collected in Trieste.

## AVICULARIAN BODIES.

The avicularian glands are more pronounced in the *Lepralia foliacea* to which I referred in the Ann. & Mag. Nat. Hist. ser. 5, vol. iii. p. 124, pl. xv. fig. 8, than in the 'Challenger' *Lepralia margaritifera*. A similar gland occurs in the vicarious avicularia of *Retepora cellulosa* from Naples, in which species there are also the suboral glands. In this case parenchym-threads at the base of the gland pass to a rosette plate, thus connecting the avicularian chamber with the next zoecium, and the other gland is joined in a similar way with another zoecium (Pl. XIX. fig. 14). Thus there is direct communication from the avicularium to two zoecia, and we find that these parenchym-threads pass to every organ of the Bryozoa.

\* Vol. xxxi. pt. lxxix.

† For the sake of brevity I shall refer to these merely as "glands."

These bodies I have, however, been better able to study in *Lepralia foliacea*, where the position and shape of the avicularian chamber is similar to that of *L. margaritifera*. The avicularian chamber is very wide, in fact the full width of the zoecium, but the glands are nevertheless curved under or over at the extremity (Pl. XIX. fig. 5). The surface of the gland shows a distinct marking of a more or less wavy description (fig. 1, right hand), and when sections are cut through the wall it is seen to be composed of small elongate cells which are in some cases distinctly nucleated (fig. 13).

These glands or hollow bodies are not attached one to another directly, but to the sheath which contains what we must at present call the avicularian body, and this to me seems the most important part of the avicularium; but before passing to its description I would point out that the glands of the avicularium and the suboral glands are both attached to the respective sheaths, though in the suboral glands the attachment occurs at the distal end by the operculum.

To return to the avicularium: there are some points which have not been described, for though a cellular body in the avicularium has long been known it has not been always made clear how this occurs in a sheath probably to be looked upon as homologous with the sheath enclosing the tentacles of the polypide. I have not, however, been able in all specimens to distinguish an avicularian sheath. This is very clear in *Bicellaria moluccensis*, Busk, of the 'Challenger'; it can also be seen in *Diachoris magellanica*; and in the *Lepralia foliacea* under discussion it is easily seen. Inside the sheath hangs the cellular body, and in many avicularia this "peculiar" or "tactile body"\* of Busk seems to be double. In *Diachoris magellanica*, Busk, although this "peculiar" body protrudes out of the avicularium in the same way as in *Bugula plumosa*, I did not see in the specimens of *D. magellanica* examined alive in Naples any setæ, though in *Bugula plumosa* † in Trieste they were easily recognized. I should, however, be glad to have the opportunity of again examining live *Diachoris* under favourable circumstances.

\* "On Avicularia," &c., Quart. Journ. Micr. Sci. vol. ii. p. 26.

† In Trieste I noticed that with clean and healthy *Bugula*, out of the Aquarium, there was no frequent snapping of the mandibles; but on the other hand the whole articulated avicularium was constantly moving deliberately backwards and forwards with the beak open, and this was only rarely closed.

In *Onychocella angulosa* a chitinous ring surrounds the end of the "peculiar body," and there is something of the same kind in *Schizoporella unicornis*, this part protruding as a double tube. The avicularia of *Onychocella angulosa* and *Schizoporella linearis* are the largest I have examined, and in neither case is there a trace of a double gland. *Schizoporella linearis* has a large avicularian chamber on the front of the zoecium, but the cellular body is very small. This raised structure was thought by Hincks\* to be an ovicell; but in my paper on the use of the mandibles I figured a mandible†, and have since been able to cut sections showing that the chamber contains nothing except the cellular body and the powerful muscles, which, from the shape of the chamber, are of course above the operculum. Dried specimens have also shown that the chamber could only be avicularian, and that the wall separating the avicularium from the zoecium is perforated.

#### SUBORAL GLANDS.

Glands have been mentioned by Ostroumoff, and Repiachoff speaks in 'Zur Naturgeschichte d. Chil. Seebryozoens,' p. 148, of two "blasenförmigen Gebilde" at each side of the operculum in *Lepralia Pallasiana*. Jullien‡, since my Supplementary 'Challenger' Report was written, has described, as a testis, an organ on one side of *Microporella violacea*. According to Jullien this is not paired, but it has much the character of the paired organs. In my sections of *Microporella violacea* I find nothing of the kind, but it is only right to say that the material I had available was not very satisfactory.

I have them in *Schizoporella sanguinea* from Trieste and Naples occurring at any rate in the autumn and in mid-winter. In the Naples specimens I did not at first see any attachment of the lower end of the gland, but have since found it in some cases; and in some specimens from Trieste this attachment to the walls of the zoecium by means of parenchym-threads is more distinct. As there are similar threads from the end of the avicularian gland in *Retepora cellulosa*, this is of considerable interest.

\* Brit. Mar. Polyzoa, p. 251.

† Journ. R. Mic. Soc. ser. 2, vol. v. p. 6, pl. xiv. fig. 8.

‡ "Du Testicule chez la *Lepralia figularis*," Mém. Soc. Zool. de France, vol. i. p. 270, pl. x. (1889).

The shape of the glands is subject to considerable change, no doubt depending both on age and activity of function; but when mature a constriction shows that they are divided into two parts, the terminal portion having much larger cells than the portion leading to the opercular opening.

In *Retepora cellulosa* there are frequently two glands on each side, as figured in my Supplementary 'Challenger' Report, pl. iii. fig. 13. The larger one seems to correspond with the glands in other species, and the difference in appearance makes it all the more difficult to understand what the function may be.

These glands are now known in a considerable number of species, for example in various *Reteporæ* and *Celleporæ*, *Lepralia Pallasiana*, *Smittia nitida* var. *ophidiana*, *Smittia bispinosa*, *Smittia trispinosa*, *Schizoporella sanguinea*, and *Microporella coriacea*.

Although thus occurring over a wide range, there are many others in which I have not found anything of the kind, but we should be alive to their sometimes having a somewhat different appearance, as can be seen from Pl. XIX. fig. 16.

In some zoœcia of *Smittia trispinosa* the gland has much the same form as in *Schizoporella sanguinea*, whereas in others it looks more like an oval or round body suspended by parenchym \*

\* In normal conditions in the Bryozoa this parenchym tissue is composed of a number of fine threads spreading through the zoœcia, but in abnormal or unhealthy conditions the appearance sometimes becomes more that of a solid cord, and I take it that the figures given by Reichert and copied by Hincks (Brit. Mar. Polyz. figs. xv. & xvii.) were taken from such specimens, for in Naples, when I examined live and recent specimens of *Zoobotryon pellucidum*, the "colonial nervous system" was always composed of numerous fine threads. These threads constantly anastomose, and in the Chilostomata not only pass to the neighbouring zoœcia, but also to all the organs, as avicularia, ovicells, ovaria, and testes.

The lower part of the cœcum is almost surrounded by this plasma, and from it numerous threads spread out. This has been described as a funicular platte, but in the specimens examined it is not a solid structure. This accumulation of plasma at the base of the cœcum suggests a simple explanation of the absorption of nourishment into the colony, which is, that as the digestion principally takes place in the cœcum the plasma absorbs the results of digestion, and so by the constant changes going on in the parenchym threads the digested nourishment is conveyed to all parts of the body. When a polypide is unable to obtain a full supply of nourishment, the organic contents of the cœcum being absorbed, the portion remaining consists of the undigestible diatoms &c., and this soon forms the brown body. The form of these parenchym threads is constantly undergoing change through the whole of the zoœcium.

and contractile tissue (fig. 16). Then, again, in *Smittia ophidiana* (fig. 15) the gland is as usual attached where the sheath joins the zoöcial wall, but below it is fastened to the sheath and not to the zoöcial wall.

Since writing the above I have obtained Harmer's suggestive paper \* "On the Nature of Excretory Processes in Marine Polyzoa," dealing with leucocytes and other cells. As many of my slides bear interestingly on the subject I shall have to return to the study of this point. However, if cells which wander about in the zoöcium become part of an encysted mass, as a "brown body" which may or may not (perhaps after weeks or months) be removed from the zoöcium, ought we to compare this with ordinary excretory processes?

### MEDIAN BODY.

In *Schizoporella sanguinea* there is another problematic structure which should certainly be studied in connexion with these glands, as it arises very near to them, if not from the same tissues. It hangs down from the opercular region, and when fully grown is sausage-shaped, and ultimately may be said to be suspended by a thin cord. This commences near the opercular opening, at first simply as a projection of the tissue, afterwards forming a thin lancet-like pendant, which gradually increases in thickness. Of course in all these calcareous species it will never be possible to follow the growth of any individual, and it is only by seeing a considerable series in decalcified preparations and sections that the growth can be worked out.

The whole body is surrounded by a membrane, and in the contents there are irregular-shaped strongly refractive masses, which appear homogeneous and do not stain (Pl. XIX. figs. 9-12). Round each of these refractive masses there is a clear space, and the general appearance of the whole structure would suggest that it is connected with reproduction, and we must ask whether it is to be compared with seasonal eggs. There is sometimes an ovarium in the same zoöcium as these sausage-like bodies.

In *Diachoris magellanica*, Busk, the so-called eggs (Jullien) have at the commencement a minute structure similar to that of the sausage-shaped bodies in *Schizoporella sanguinea*.

\* Micro. Journ. vol. xxxiii. n. s. p. 123.



There are both ovaries and testes in the same zoëcia with these so-called eggs. It may be that there are two different kinds of reproduction in the *Gymnolæmata* as well as in *Phylactolæmata*.

Although, so far as I am aware, the way in which these sausage-shaped bodies grow has no parallel in other species, yet other growths should be studied to see whether they can throw light upon this. In nearly all species budding takes place close to the operculum, though in many works buds are stated to arise from the proximal wall of the zoëcium. It is true that this is the case in some, but not all, species of *Flustra*, and no doubt budding has been more often examined in this genus than in those which are more concealed by the calcareous covering. In cases where the budding is from the proximal end I have noticed that there is a great development of parenchym in the distal end of the next older zoëcium, and this leads up to the distal rosette-plate, giving the bud the appearance of starting from the rosette-plate.

In *Adeonella polystomella*, Reuss, there is a small round body so close to the operculum that it seems attached to it. The parenchym comes up to and sometimes partly surrounds it, and from this part the buds arise.

It would seem that reproduction takes place in the Bryozoa in more ways than has been commonly supposed, as there is considerable difference in the early division of the ova and in the stage in which the ovum passes into the ovicell, and in many cases the larva develops in an internal chamber divided off from the rest of the zoëcium, and not in an external ovicell.

In *Caberea Boryi*, Aud., the ovarium occurs near the distal end of the zoëcium, and close to it there is in most cases an oval body surrounded by a relatively thick cover which looks as though it were chitinous, though, as it stains, this is probably not the case.

The contents appear homogeneous; and here we may again ask whether this is a seasonal egg. There are, of course, also ova and larvæ in the ovicells of this species.

## EXPLANATION OF PLATE XIX.

- Fig. 1. Section through the avicularian chamber of *Lepralia foliacea*, Ell. & Sol. *m*, mandible; *g*, gland-like bodies, the left one is shown in section, the right-hand one shows the surface; *c*, "cellular body."  $\times 250$ .
2. Longitudinal section of the avicularian chamber of *Lepralia foliacea* cutting through the gland-like body.  $\times 250$ .
3. Avicularium of *Bicellaria moluccensis*, Busk.—*m*, &c. as above.  $\times 125$ .
4. Section of zoecium of *Lepralia foliacea* showing the avicularian chamber *in situ*. The polypide is given in order that the relative position may be better understood, and although the different parts are drawn somewhat diagrammatically, all are taken from actual specimens. The sacs are shown in section.  $\times 85$ .
5. Avicularian chamber of *Lepralia foliacea*.  $\times 85$ .
6. Gland-like body of *Schizoporella sanguinea*, Norm.  $\times 500$ .
7. Operculum and distal end of *Schizoporella sanguinea*. The gland-like bodies are shown in section.  $\times 85$ .
8. Ditto, showing (*a*) growth from tissue at the opercular end. The right gland-like body is shown in section and with an attachment to the zoecial wall.  $\times 85$ .
9. The prolongation of this tissue has now grown into the median body (*s*), which lies diagonally across the upper part of the zoecium.  $\times 85$ .
10. Ditto. (*s*) hangs from the centre attached merely by a fine cord.  $\times 85$ .
11. Longitudinal section of a median body from *Schizoporella sanguinea*, showing the refracting masses.  $\times 250$ .
12. Ditto. Transverse section.  $\times 250$ .
13. Nucleated cells of gland of *Schizoporella sanguinea*.  $\times 500$ .
14. Section of *Retepora cellulosa*, L., showing vicarious avicularia with gland-like bodies. Each avicularium is connected through rosette-plates to two zoecia.  $\times 85$ .
15. Distal end of *Smittia nitida*, var. *ophidiana*, Waters.  $\times 85$ .
16. Distal end of *Smittia trispinosa*, Johnst.  $\times 85$ .
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Some Observations on the Relation of the *Acaridæ* to the *Arachnida*. By HENRY M. BERNARD, M.A. (Communicated by A. D. MICHAEL, F.L.S.)

[Read 21st April, 1892.]

(PLATE XX.)

IN trying lately to deduce the Copepoda from some primitive form of *Apus*, which latter I had endeavoured to establish as the probable racial form of the majority of the modern Crustacea, I was driven to the conclusion that they could only be deduced from the larval forms of such animals. I was compelled to take this view because the organization of the Copepoda appeared to be much lower than that of any of the forms which I considered primitive. It occurred to me at the time that the relation of the Mites to the other Arachnids might perhaps be explained on the same principle. The principle is not that the animals degenerate, but that, in the struggle for existence, it has proved advantageous to many to remain at a larval stage, and thus minute enough to be inconspicuous both for purposes of escape and of attack. It may also be worth remarking that the more minute an animal is, the more abundant, relatively speaking, is the amount of organic matter at its disposal for purposes of nutrition.

It is true that, as the term is ordinarily used, this fixation of a larval stage would be called "degeneration;" but I think that the word "degeneration" is hardly applicable in this connection, and that it should be confined to those cases in which highly developed organs and functions, once acquired, have been lost owing to parasitism. It seems to me that no one who has studied the Mites, even in the most cursory manner, can believe that they are degenerated Arachnids in this latter sense, although they seem to have been generally called so. Many of them are active predatory creatures, with no such easy-going habits of life as would lead to degeneration; while among the Acarids themselves there are forms which have very clearly degenerated through parasitism, not from the Arachnidan, but from the Acaridan standard. I shall endeavour to show that this "degeneration" from the Arachnidan standpoint is almost purely quantitative, not qualitative.

If, then, they are not degenerated Arachnids (*i. e.* assuming

them for the moment to be Arachnids), we must explain their minute size on some other principle, for, whether we adopt the Eurypterine or the more directly Annelidan origin of the Arachnida, we can hardly doubt that the primitive Arachnid was of much more imposing proportions than these microscopic creatures.

I propose in this paper to see whether it is possible to explain the origin of the Mites as I have endeavoured to explain that of the Copepoda\*. I shall try to show that the Mites are not *degenerated* Arachnids, but Arachnids permanently fixed at a larval stage of development.

The establishment of this supposition appears, at the outset, to be by no means easy. Many of the Mites are very highly specialized, and reveal little as to their earlier morphology. Accident, however, threw in my way a form which seems to be rather primitive and to throw some light on the subject. I refer to the common *Tetranychus tiliarum* (Herm.), which I found swarming in countless thousands down a lime-tree last autumn, carefully keeping on the sheltered side of the tree.

This Mite is morphologically of importance, because its segmentation can be clearly made out, and it is on this naturally that one chiefly relies for the explanation of its morphology.

Fig. 1 (Pl. XX.) is a dorsal view of the animal, showing the arrangement of the hairs, the dorsal muscles, and the three segmental furrows and the relation of these furrows to the legs.

The muscles would, I think, clearly show that these two middle regions are true segments, even if the limbs did not make this evident. I feel justified, therefore, in diagrammatizing the segmentation of *Tetranychus* in the way shown in fig. 2 B †.

We have the typical six segments of the Arachnidan cephalothorax (leaving out of consideration the possible vanished antennal segment), followed by *three* abdominal segments. The last or third segment, as we should expect, contains the anal aperture; just in front of the anal aperture is the genital aperture, whether on the first or second segment I cannot say; I have marked it between them.

When we compare this with the diagrammatic segmentation of an Arachnid (fig. 2 A), we find that the two agree very closely,

\* 'The Apodidæ.' Macmillan, 1892.

† We here assume that the mouth-parts of the Mites in general are purely Arachnidan, as they most clearly are in *Tetranychus*. We shall, however, return to this point.

with, however, this remarkable difference—some seven segments posterior to the genital aperture and in front of the anal aperture are missing.

Now when we remember that in the development of all articulate animals the rule is that new segments are added in front of the anal segment, we are justified in assuming, not only that the anal segments are homologous, but that the first eight segments in the Acarid are homologous with the first eight segments in the Araneid.

The segmentation of *Tetranychus* shows us very clearly, then, that it ceased to develop new segments as soon as eight segments had been formed, *i. e.* as soon as it had reached the typical position for the genital aperture, whereas, in the Araneids, some seven more segments are added between the genital aperture and the terminal or anal segment. This is the first and most important point, helping to bear out our suggestion that the Mites are Arachnids arrested in their development. I may add that the fact that no "waist" is formed in the Acarid between the 6th and 7th segment, as in the Araneid, is a point of no importance. A waist is simply a mechanical device to enable the animal to bend its body, which the Mites as a rule do not require; a few develop slight waists, but in another place, as will be mentioned below.

It is of course not necessary to suppose that all the Mites are to be deduced from the *same* Arachnida, or that all were arrested exactly at the same *stage* in their development. Some may have developed more abdominal segments than *Tetranychus*. On the other hand, it would be difficult for them to develop fewer. It would be necessary to develop some portion of the abdomen over and above the anal segment, as the genital glands typically arise in this part of the body, and without the power of reproduction the Mites of course could never have persisted as a distinct family.

Kramer has described the segmentation of a Mite (*Alycus roseus*?) with seven abdominal segments. Kramer counts nine by reckoning the last two thoracic segments as abdominal. This error arises from misunderstanding the arrangement of the limbs so common among the Mites, two pairs pointing forwards and two backwards, with a considerable space between the anterior and posterior pairs, which is simply an adaptive modification. The conclusion drawn from it by Kramer and others, that the

line between these anterior and posterior pairs of limbs is the true waist or division between thorax and abdomen, cannot be maintained. The fact that *Alycus roseus* has a waist, as described by Kramer, may be due to the comparatively great length of its abdomen, all the larger species being capable of bending the body somewhat. It is, however, right to add that the claim that the line dividing the limbs into two pairs is the true demarcation between thorax and abdomen does not rest only on the arrangement of these limbs, but also on the fact that, in some Acarids, the mouth-parts are so specialized and altered from the primitive Arachnidan type that some would find in them 2nd maxillæ and an underlip presumably homologous with these same parts in the Hexapoda. I shall return to this presently.

My argument, however, does not rest only on the segmentation, although this is certainly the most important point. This arrested development theory throws some light on the nature and position of some of the internal organs.

Fig. 3 B (Pl. XX.) is adapted from Winkler's account of the anatomy of *Gamasus fucorum*. It shows the extraordinary position of the heart. If, however, we compare this with fig. 3 A, we have this position and shape very clearly explained. The *Gamasus* heart is, as it were, only the first chamber of the adult Arachnidan heart. The arrest of the further development of the abdomen naturally arrested the further growth of the heart.

This theory is of course different from that which sees progressive stages of degeneration in the hearts of the Phalangidæ, Chernetidæ, and Acaridæ. It is not impossible that some of the Acaridæ are to be deduced from larval Phalangidæ, but not as a result of degeneration, but as a fixation of larval forms. The heart of *Gamasus* is only quantitatively degenerated; relatively to the size of the animal it stands on the same level of organization as that of the adult Araneid.

Fig. 4 B is a diagram of the alimentary canal of a *Gamasus*, also after Winkler. If we compare this with the digestive tract of an adult Arachnid (e. g. *Mygale*, fig. 4 A), we see what is the part actually missing. It is again clearly the abdominal part, i. e. that portion of the mid-gut which lies between the thorax and the rectal vesicle. This offers further support to our theory that some seven segments between the 1st and 2nd abdominal and the anal segments were not developed. Here again we find the difference is more quantitative than qualitative.

The nervous system also offers slight confirmatory evidence. Fig. 5 (A, B) compares the nervous systems of an Arachnid (*Mygale*, A) and of a Mite (*Gamasus*, B). Only the great ventral ganglionic mass is developed in the latter. All its great diverging nerves correspond with those from the ventral ganglion of *Mygale*. When we reach the abdominal nerves, however, we find that in *Gamasus* they branch out direct from the sternal mass, while in the Araneid, in accordance with the form of the animal, they run together in a long strand (to swell in some cases, as in *Mygale*, into an abdominal ganglion) into the abdomen, and there branch out among the viscera.

The arguments here brought forward to show that the Acarids are larval Araneids receive some slight support from the fact that as a general rule in the Acarids the eggs are of an enormous size as compared with the parent animal. Although the Acarid stopped growing long before reaching the full number of segments of its adult original form, there was no reason why the eggs developing from the germinal epithelium should diminish in size in correspondence with the altered size of the parent. The size of the egg would of course gradually be fixed for each species by natural selection. It is, however, significant to find that, as a rule, the eggs of the Acaridæ are enormous, relatively, that is to say, to the size of the animals. This seems to indicate that the level of organization in the Mites has been well sustained, and that the alteration is almost entirely one of size.

These few comparisons between the internal structure of the Mites and that of other Arachnids (chiefly Araneids) lend considerable support to the evidence afforded by the segmentation, that the former are Araneids arrested in their development, *i. e.* that they are fixed larval forms.

The foregoing argument, it is clear, gains much in strength if it can be shown that *Tetranychus* can really claim to be a primitive form. I think that a study of the mouth-parts leaves little doubt on this point.

The mandibles have been somewhat telescoped into the body and are fused together, but their outlines are still clear (fig. 1). Although in *Tetranychus tiliarum* their distal joints have been modified into long retractile piercing-tubes, in another apparently allied species described by Flögel as parasitic on Spiders (in whose body its bite gives rise to a curious dendriform tissue) the

mandibles are typical biting-jaws, like those of an ordinary Spider.

Again, the pedipalps are equally clearly Arachnidan. The basal parts are fused in the middle line and prolonged into a kind of chitinous beak, while their palps are 4-jointed, the penultimate joint being prolonged into a slightly curved hook which, with the terminal joint, forms a kind of chela. There is therefore in this case no difficulty whatever in homologizing the mouth-parts with those of an Araneid.

Following upon these mouth-appendages we have the typical four pairs of ambulatory legs of the thorax. These together make the typical six pairs of appendages of the Arachnids.

This certainly seems the simplest and most natural homology of the Acaridan limbs. It agrees best with all we know as to the development of the Acarids, which bears such striking resemblance to that of the Arachnids. It is necessary to emphasize this point, which we have hitherto assumed, because of the desire on the part of some to find other (? Hexapodan) homologies for the mouth-parts and limbs of the Acarids. Haller, for instance, claims a distinct 2nd pair of maxillæ and an underlip. The difficulties in the way of this interpretation of the Acaridan morphology are, it seems to me, overwhelming.

All other Arthropods, for instance, have antennæ, while the Acaridæ agree with the Arachnids in not having such appendages. Further, it is extremely doubtful whether the special structures which Haller claims as 2nd maxillæ and underlips can really be so interpreted. They appear to be secondary modifications in adaptation to the needs of the animal, and quite in accordance with the extraordinary specialization exhibited by so many of the Acaridæ in almost every part of the body. No trace of such extra mouth-parts can be found in such simple forms as *Tetranychus*\*. Winkler has described the underlip of *Gamasus*, and pointed out its very probable homology with the underlip of a Spider.

It seems to me, then, that this attempted change in the classification of the Acarids is in a high degree strained, in comparison with the usual classification which ranks them with the Arachnida, and which is based upon developmental history, upon

\* Mr. A. D. Michael, one of the first authorities on the Acarids, informs me that he certainly could not claim for the Mites any appendages homologous with the 2nd maxillæ and labium of the Hexapoda.



general agreement in number and arrangement of appendages, and upon certain unmistakable likenesses in inner organization.

Of these last, perhaps the common possession of a tendinous endosternite is the most striking. This structure, whose probable origin I have described in another place\*, only occurs, well developed †, in the Arachnida and in the archaic Crustacea, *Apus* and *Limulus*. We have not hesitated, therefore, in following the usual classification, and in claiming the Acarids as Arachnids throughout this paper.

I may sum up the arguments which lead me to believe that the Acaridæ are Araneids fixed at a larval stage of development because of the many advantages which animals of such small size have over larger ones, as follows:—

(1) On comparing the segmentation of a simple form of Acarid with that of an Araneid, seven abdominal segments in front of the anal segment are not developed, while all the developed segments in the Acarids are easily homologized with the similar number of anterior segments of the Araneid, segment with segment.

(2) We find, on comparing the alimentary canal of the Acarid with that of an Araneid, that it is clearly the abdominal part of the latter which is missing in the former.

(3) The heart of the Acarid (as exemplified by *Gamasus*) is clearly, both in shape and position, an Araneid heart arrested in its development; the abdominal extension of it is wanting.

(4) The ventral ganglionic masses in both agree in almost every point, the only difference being due to the greater development of the abdomen in the Araneid.

(5) The size of the eggs of the Acaridæ is often out of all proportion to the size of the animals themselves; this seems to show that, while the animal has diminished in size, the eggs have retained more nearly the size of those of the original adult forms.

(6) A further argument, based on the position of the tracheæ, will be adduced later on.

If the principle by which we have attempted to explain the origin of the Acaridæ holds good, it is probable that it has been of very general application in the development of the

\* 'The Apodidæ' (Macmillan, 1892), pp. 56, 57.

† There can be little doubt that a rudiment of it persists in *Astacus*.

Animal Kingdom. We have already elsewhere\* endeavoured to explain by it the comparatively low state of organization and the diminutive size of many of the smaller forms of modern Crustacea. Indeed, we might institute many very interesting parallels between the smaller Crustacea and the Acaridæ; for instance, we have in the Ostracoda the abdomen with very few segments developed, and only occasionally a heart, the heart being, in all probability, the anterior end of the long dorsal vessels of their more developed ancestors—primitive Apodidæ or Trilobites.

It is further clear that the principle of the cessation of the development of segments can only be used for articulate animals whose method of development is still the primitive one for such animals, namely, that the segments are differentiated regularly in front of the anal segment. This method of regular axial development is often lost, owing to great specialization. In this case the segments are marked off upon the surface of a germinal disc. This modification would obviously allow of slight variations† in the inherited number of segments for each region of the body, variations which would hardly be possible so long as the axial method of development was retained. The Crustacea are a very interesting group in this respect; we have the primitive forms still developing from a *Nauplius* by the regular axial addition of new segments, while the higher forms, such as *Astacus*, mark off the segments almost simultaneously on a germinal disc.

The fact that in the Spiders the segments are marked off on the germ in no way interferes with our main argument, because the whole arrangement of the segmentations in the Spider-embryo shows very clearly that it is only a recent modification of the original method of axial development. The Spiders, indeed, like the higher Crustacea, form an excellent example of animals clearly derived from articulate ancestors in which, owing to high specialization, the old method of regular development of

\* 'The Apodidæ.' Macmillan, 1892.

† Professor Howes has kindly drawn my attention to the case of *Pipa*, which has only eight dorsal vertebræ, whereas all the other Anura have nine. The difference between the two methods of development is of great importance in the question of intercalation and excalation of segments; while it is obviously impossible that these processes could take place under the primitive axial method of development, they are quite possible under the later and more specialized method

new segments in front of the anal segment is in process of being lost, the segments being marked off nearly simultaneously on a germinal disc.

The absence of the seven abdominal Arachnidan segments from the Acaridæ is not a true case of excalation, because the method of development is still sufficiently axial to lead us to believe that when the Acaridæ were specialized this method of development was still the rule. These seven missing segments were therefore only excalated in the sense that the development of new segments ceased before reaching them.

This method of explaining the origin of the Acarids leads us almost necessarily to assume that the Acarids in each region were the fixed larval forms of the Araneids of that region—fixed, that is, at the time when the Araneids themselves had become specialized for their different habits of life.

It seems to me that the young of Araneids infesting trees or bushes would be very likely to find it advantageous to remain small and inconspicuous. The juices of the plant afford an abundant supply of nourishment always at hand, while their small size would render them comparatively safe, at least from the larger animals which prey on Spiders. Their small size, on the other hand, would make them very liable to be devoured by Ants, against whom each species has a special method of protection. *Tetranychus tiliarum* seems to live under a web which it spins; other Mites form galls, probably burrowing into the leaf originally to take refuge from the Ants. The Oribatidæ can afford to wander about freely, as, apparently after trying various disguises\*, they have provided themselves with a thick chitinous shell, like a suit of armour. Others have even succeeded in making themselves the honoured guests, or valued slaves, of their foes†.

I hope in a subsequent communication to give an account of the minute anatomy of *Tetranychus tiliarum*.

Before concluding this attempt to show that the Acaridæ may be explained as Arachnids (probably Araneids) fixed in a larval condition, there are two points of considerable interest which cannot be ignored in any discussion as to their morphology.

\* See the beautiful disguises of some of the larvæ in Michael's 'Monograph of the Oribatidæ,' Ray Society.

† Michael, *vide* abstract in 'Nature,' vol. xlv. p. 164.

There is a point in the development of the Mites which has received considerable attention: that is the fact that the earliest larva has only three pairs of legs (*cf.* fig. 3 B); the fourth pair, which is usually the most posterior, is added as a further developmental process. At first sight this seems greatly to favour my theory of the undeveloped state of the hind body. But until more light has been thrown on Winkler's observation, that four pairs of limbs develop in the embryo, one pair being reabsorbed, only to be developed again in a later stage, I can hardly claim it as a support to my theory.

It is not easy to see the true bearing of Winkler's observation on the origin of the Acaridæ. The loss of a pair of legs is probably an adaptative modification to larval life\*. As far as I can see, the temporary appearance of the fourth pair of legs in the embryo seems to show a tendency in the embryo to develop into the adult Araneid, as if the full number of abdominal segments were about to be developed. The sudden arrest of development, probably consequent on the exhaustion of the available supply of nutriment, leads to the reabsorption of the last pair of limbs, the power to redevelop them being only gradually regained after the larva has obtained for itself a fresh store of nourishment.

The tracheæ also demand some attention. Their position lends considerable support to our theory. The stigmata occur in many different parts of the body, but almost invariably on the cephalothorax, in some cases even so far forward as to be on the dorsal surface at the base of the mandibles. In the Arachnida (excluding the Acaridæ) the stigmata are, with one interesting exception, abdominal. The Solpugidæ have stigmata on the thorax. The Mites thus form a most interesting and important link between the Arachnids and the Antennate Tracheata. In the Araneids we have purely abdominal stigmata with tracheæ, both book-leaf and tubular. In the Solpugidæ we have tubular tracheæ alone, opening on both abdomen and thorax; and in the Mites we find the stigmata almost invariably on the thorax, the tracheæ being purely tubular. Now it is generally thought that the Solpugidæ are a somewhat primitive form of Arachnids; and if our theory is true, that the Acarids are larval Araneids, they would also be on the level of primitive forms in which we might naturally expect to find a more primitive tracheal system than

\* A similar phenomenon occurs in the development of some Malacostraca, *cf.* Lang's 'Textbook of Comparative Anatomy,' pp. 410-411.

that in the adult forms, especially as this branching off of the Acaridæ from the Araneidæ probably took place ages ago, when the latter were themselves first specialized for their peculiar manner of life.

Hence we find that, as we go backwards from the specialized Araneids with their book-leaf tracheæ confined to the abdomen, we come to the Acarids with purely tubular tracheæ confined to the thorax, according to my theory necessarily, because so little of the abdomen is developed.

The presence of these tubular cephalothoracic tracheæ in the Arachnida is not only no difficulty, but is, on the contrary, most natural if the Arachnida are classed with the other Tracheata. The modern Hexapod has stigmata both on the thorax and abdomen, while the primitive forms had stigmata on all the thoracic segments, as is clearly seen in the embryos of many forms. The typical Myriapod has stigmata on every leg-bearing segment; and *Scolopendrella* is said to have them on the head; and lastly *Peripatus* has them all over the body. The Mites, then, in developing tracheæ in the anterior part of the cephalothorax have either retained the condition common to all primitive Tracheata, or else have returned to it, owing to their failure to develop a full number of abdominal segments.

This simple explanation of the facts is in striking contrast to the difficulties in the way of those who would deduce the Arachnidan tracheæ from the embedded gills of the abdominal legs of a *Limulus*-like ancestor. The only possible way to get over the difficulty is to assume that tracheæ have had four more or less independent origins. In the Hexapoda they have had one origin; in the Arachnida two independent origins—the abdominal book-leaf tracheæ from embedded leg-gills, the thoracic tubular tracheæ in some other way again, while the abdominal tubular tracheæ are modified book-leaf tracheæ. In one and the same group the same structure, viz. the tubular tracheæ, have thus had two independent origins! The more closely we examine this subject, in fact, the more improbable does the gill-origin of tracheæ appear. We have, for example, in *Ixodes ricinus* a pair of stigmata lying just behind the last pair of limbs. Until more is known of the segmentation of *Ixodes*, it is not easy to define the exact position of these stigmata; but they belong either to the last thoracic or to the first abdominal segment. However that may be, it seems clear from their position that they are closely related to the stigmata of the book-leaf tracheæ lying

on the second abdominal segment of the Araneids. Pagenstecher's original drawing of the tracheæ opening through these stigmata is very instructive. We have a short thick trunk, ending in a close tuft of short tubules. They lie, not only in position on the body, but also in structure, halfway between the book-leaf tracheæ and the purely tubular thoracic tracheæ. Now, while it is impossible to assume that the *thoracic* tubular tracheæ came from embedded gills, it is not only not impossible, but highly probable, that both tubular and book-leaf tracheæ were derived from such tuft-like tracheæ opening as we have described on the first abdominal (or ? last thoracic) segment of *Ixodes*. The tubular tracheæ are tuft-tracheæ specialized for the respiration of the tissues directly. The book-leaf tracheæ are specialized for the oxygenation of a *blood-stream*, and thus of the tissues indirectly. A close parallel to this variation of tracheal arrangement in the Arachnids is afforded by the Myriapods, where, though tubular tracheæ are the rule, one group, the Scutigera, have a kind of book-leaf system specialized for the aëration of the blood in the pericardium\*.

If, therefore, the Acaridæ are true Arachnids, their tracheæ seriously complicate the position of those who would sever the Arachnida from the other Tracheata. Instead of one origin for these remarkable breathing-organs, they are forced, as above described, to assume *four* more or less distinct origins.

Although the important bearing of the Acaridæ on this question of the origin of the Arachnida has by no means been overlooked†, it has not received the attention it deserves. To me it appears strongly to confirm the old classification which placed the Arachnida with the other Tracheata.

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## EXPLANATION OF PLATE XX.

N.B.—In all the drawings the line across the figure indicates the line of demarcation between thorax and abdomen.

- Fig. 1. Outline of *Tetranychus tiliarum*, showing the three segmental furrows with arrangement of dorsal musculature; the dots show the position of the bristles. 1. The mandibles fused in the middle line and somewhat telescoped into the body. 2. The pedipalps also fused in the middle line. 3, 4, 5, 6. The four pairs of ambulatory limbs belonging to the four thoracic segments. I, II, III. The three abdominal segments, with the genital and anal apertures.
- Fig. 2. A. Diagrammatic segmentation of an Araneid. 1-6. The six segments of the cephalothorax, each provided with a pair of limbs. I-X. The segments of the abdomen, showing the positions of the genital and anal apertures.
- B. Segmentation of *Tetranychus* (cf. fig. 1) for comparison with A. 1-6. The cephalothoracic segments homologous with 1-6 in A. I, II, III. The abdominal segments, of which I and II are homologous with I and II in A, and III homologous with X, showing that seven segments are undeveloped.
- Fig. 3. A. Diagram of heart of an Araneid lying entirely in the abdomen.
- B. Diagram of 3-legged larva of *Gamasus fucorum* (adapted from Winkler), showing position and stage of development of the heart for comparison with A.
- Fig. 4 (from Lang's 'Text-book of Comparative Anatomy'). A. Alimentary canal of an Araneid (*Mygale*): *m*, Malpighian tubule; *rv*, rectal vesicle. B. The same of *Gamasus*. A comparison of the two shows that it is the abdominal portion of the adult Araneid alimentary canal which is not developed in the Mite.
- Fig. 5. A. Ventral ganglion of an Araneid (*Mygale*, adapted from Lang's 'Text-book of Comparative Anatomy'). 2-6. The five posterior cephalothoracic appendages, each supplied with a nerve. *a, a*. The visceral nerves radiating from an abdominal ganglion.
- B. The same of *Gamasus* (after Winkler). 2-6. Nerves branching to 2nd to 6th appendages. *a, a*. The ventral nerves branching directly from the ventral ganglion.

Studies of British Tree- and Earth-worms.  
By the Rev. HILDERIC FRIEND, M.A., F.L.S.

[Read 5th May, 1892.]

(PLATE XXI.)

I. ON THE TREE-WORMS OF GREAT BRITAIN.

HITHERTO no attention whatever seems to have been paid by English naturalists to that group of worms whose principal habitat is the old and decaying stumps or trunks of fallen trees, and whose chief service consists in the breaking up of useless timber, and reducing it to vegetable mould. When I commenced the study of these animals two years ago nothing was known of the subject in this country, and I was therefore compelled to examine the works of such continental naturalists as Eisen, Rosa, and Levinsen, in order to ascertain the character of those tree-worms which had already been made known to the scientific world. Thanks to their industry it has been possible for me to identify every species hitherto discovered in Great Britain. So far as present research enables us to speak definitely on the subject, we have no tree-worms peculiar to this island. Every species hitherto examined is known to occur in one or other of the countries of Europe, from Russia and Scandinavia to Brittany and the Italian peninsula.

But though it has not fallen to the lot of our countrymen to add any species of arboreal worm to the list of new discoveries, it must be admitted that foreign writers on the subject have, so far, almost without exception, failed to recognize the affinities of the group, and present us with any satisfactory system of classification. I purpose therefore, in the present paper, giving the whole subject a careful revision in the light of our indigenous species, with this proviso, however, that when our boreal species have been as carefully worked as I have worked those species which are found south of the Clyde, it may be necessary to somewhat modify the characters of the group.

Eisen was the first naturalist to show that the worms which were formerly included in the genus *Lumbricus* were marked by such differences as would justify the creation of new genera. He accordingly, in 1873, took the family Lumbricidæ and split it up into four genera—*Lumbricus*, *Allolobophora*, *Dendrobæna*, and



*Allurus*. He has since added *Tetragonurus*. The curious point to be noticed is, that though Eisen created the genus *Dendrobæna*, he did not recognize the species which would naturally fall under that generic designation, and hence his perfectly natural and appropriate term has been quietly ignored. It is my purpose, therefore, to revive the term first introduced by Eisen, and to show which of the species hitherto placed under *Lumbricus* and *Allolobophora* must be transferred to the subgenus *Dendrobæna*.

In revising Eisen's genus, however, it will be necessary to extend the characters considerably, since he included therein only one species, and that, till now, a very badly described and little understood worm. His diagnosis \* is as follows:—

DENDROBÆNA, n. gen.

*Tubercula ventralia* in segmento 14 [=15 Eng. method].

*Setæ* ubique æquo intervallo distantes, exceptis duabus summis, quarum intervallum aliquanto majus est.

*Lobus cephalicus* tres partes segmenti buccalis occupans.

Referring to this subject, Dr. Benham says †:—"Eisen was the first to subdivide the genus *Lumbricus* into subgenera, according to the relative amount of dovetailing of the prostomium into the peristomium. This is accompanied by certain other characters, which have been held sufficient to characterize genera in other cases. So that I have retained his subdivisions *Lumbricus* and *Allolobophora*; but as his genus *Dendrobæna* is only distinguished from the latter genus in having all the setæ equidistant, and as all stages occurring in the separation are found in *Allolobophora*, I agree with Rosa that, we ought not to recognize it."

Consequently the name has been dropped, and in Beddard's 'Classification and Distribution of Earthworms,' 1891, is omitted from notice altogether. The statement of Benham to the effect that every degree of separation of the setæ is found in *Allolobophora* is true till we remove the species which properly fall under the genus *Dendrobæna*, and it is strange that neither Eisen,

\* "Om Skand. Lumbr.," in *Öfver. af K. Vet.-Akad. Förh.* 1873, no. 8, p. 53.

† "An Attempt to Classify Earthworms," in *Quart. Journal of Micr. Sci.* vol. xxxi. pt. ii. (1890) p. 263.

Rosa, nor Benham has seen the force of this character. Almost without exception do we find that the species of *Allolobophora*, as classified by Eisen, which have the setæ widely separated, are dendrobænic in character. It is true that I shall have to deal with one exception, but this is due to the fact that we are not yet acquainted with all the species which exist, and cannot therefore assign those with which we are familiar their exact position.

I show further on\* that in the genus *Lumbricus* we have always a perfect mortise and tenon arrangement of the anterior segments, a girdle composed of six segments, four of which bear the *tubercula pubertatis*, while the colour is purple-brown with iridescence, and the worms secrete no pigmented substance from the dorsal pores. The genus *Allolobophora*, as at present understood, includes worms of very varied characters, and I find that our British species fall readily into groups, of which I propose to name three as follows:—

§ 1. LUMBRICOIDEA. Type *Allolobophora longa*, Ude.

§ 2. MUCIDA. Type *Allolobophora mucosa*, Eisen.

§ 3. DENDROBÆNA. Type *Allolobophora celtica*, Rosa.

There are two or three species which do not fit into either of these groups, but their classification has been temporarily set forth by Dr. Rosa. Now I do not intend at present to touch upon the first two groups. They have certain well-marked characters which will justify, in time, their erection into new subgenera†. For the present we will deal only with section 3. In so doing I shall be compelled to bring one of the species out of the genus *Lumbricus*, and two or three from Eisen's genus *Allolobophora*. The characters of the group will be better understood when the different species have been discussed. Generally speaking, however, we may say that the worms are rose-red or flesh-coloured, small, with setæ more or less widely separated, arboreal in character, or found usually in and about decaying timber or tree refuse.

I have named *Allolobophora celtica*, Rosa, as the type. Rosa's original description‡ was based upon three living specimens

\* "On a Species of *Lumbricus* new to Science," *infra*, p. 306.

† See Rosa's 'Lumbrici del Piemonte,' where some of these points are more fully treated.

‡ 'Bolletino dei Musei di Zool. ed Anat. Comp. Torino,' vol. i. no. 2, April 1886.

received from Brest, in Brittany, during the month of March 1886. It may be here remarked that in England March is an excellent month for collecting earthworms, as the sexual organs are then becoming active and fully developed. Rosa states that the worms are about equal in dimensions to *Lumbricus purpureus*, Eisen; being from 2 to  $2\frac{1}{2}$  millim. in diameter, and 35 to 40 in length. The form is cylindrical, with the posterior part somewhat attenuated. Colour violaceo-pallid dorsally, carneo-livid ventrally. Segments about 100 in number. Cephalic lobe or prostomium with a large backward prolongation which cuts or dovetails into the peristomium to about one half its longitudinal diameter, the lobe being destitute of an inferior longitudinal groove. The male pore situated on segment 15, and extending from the second to the third setæ, the two adjoining segments (14 and 16) being affected. Rosa terms these papillæ carrying the male pore the atria, but Beddard disputes the strict accuracy of this designation\*. I prefer for the present to state, when these glandular processes occur, that the male pore is carried by or borne on papillæ. The female pore is well seen, says Rosa, as a small fissure on each side of segment 14 against the second setæ, but on the side external to that occupied by the male pore. The girdle occupies six segments, extending over 31-36, slightly raised and not very closely fused. The *tubercula pubertatis* occur ventrally on segments 33, 34, in the form of a continuous ridge (not on papillæ as in *Allolobophora chlorotica*, for example). Setæ distant, the lateral interval increasing from below upwards, that is, the interval between 2-3 is greater than between 1-2, and less than that between 3-4; the ventral inferior (1-1) not greater than the lateral inferior (1-2); the dorsal interval (4-4) being about twice that of the lateral superior (3-4). The setæ on the ventral surface of segments 31, 32, 35 (before and behind the *tubercula pubertatis*) borne on relieved papillæ. An interesting note on the nephridiopores, which need not be reproduced in this connection, brings Rosa's account to a close.

In 1890 I found three specimens of this worm a few miles north of Langholm, N.B., and the same year three others were discovered in an immature condition near Carlisle, when they were at first mistaken for the young of *Lumbricus purpureus*, Eisen. More recently I have received specimens from, or col-

\* "The Classification and Distribution of Earthworms," in 'Proceedings of the Royal Physical Society of Edinburgh,' vol. x. p. 264.

lected them myself in, Devonshire, Gloucestershire, Yorkshire, Northants, Lancashire, Lanark, Sussex, and elsewhere. It is therefore evident that the species is widely distributed in Britain.

It only needs that this species should be studied by the side of *Allolobophora Boeckii*, the type upon which Eisen founded the subgenus *Dendrobæna*, to show that they are very closely allied. I will not at this point inquire what relationship exists between *A. Boeckii* and *Lumbricus puter*, Hoffmeister. Eisen says the girdle is usually composed of five segments (29-33), over three of which (31-33) the *tubercula pubertatis* extend. I give the figures according to the English notation, which makes the peristomium the first segment, and places the male pore on the 15th. Eisen's description published in 1870 is faulty owing to the inclusion of two or three species under one name. The generic title adopted in 1873 was based upon the fact that the worm was found under the bark of decaying trees. It has often been confused with another closely allied species which Eisen first differentiated under the title of *Allolobophora subrubicunda*. This worm is very widely distributed, and when once seen is not easily mistaken for any other, notwithstanding the fact that its girdle or clitellum occupies almost exactly the same position as that of one or two other species. It is true that the Gilt-tail (*Allolobophora subrubicunda*, Eisen) is by no means confined to woodlands, but its affinities are entirely with the *Dendrobænas*, and it specially delights to live among fallen and decaying leaves, dead branches of trees, and similar vegetable debris. I have found it depositing its egg-capsules quite under the bark of decaying trees.

When Eisen established the genus *Dendrobæna* it is remarkable that he did not place therein his new species *Allolobophora arborea*. It is described as an arboreal or dendrobænic species, and its characters were in many respects so similar to those of his type of the new genus that at first we are astonished to find the two placed under different genera. The fault lay in the fact that Eisen placed too much stress upon one character, to the exclusion of the rest. With him, any worm whose prostomium cut the peristomium in two was a *Lumbricus*, whatever other characters it possessed. In *Dendrobæna* the prostomium occupied about three parts of the peristomium, while in *Allolobophora* the prostomium only slightly cut into or divided the buccal segment. It is now found that this is far too arbitrary and unnatural an

arrangement, and that while undoubtedly every true *Lumbricus* has the peristomium completely divided by the hinder process of the prostomium, yet not every worm with this feature is a true *Lumbricus*. Want of attention to this fact has led to further confusion in the case of a recently discovered worm which Levinsen has described as *Lumbricus Eiseni*. This worm, which was first described from specimens found at Copenhagen, has been obtained by Rosa in Italy, and by myself in various parts of Great Britain; and is a true *Dendrobæna*, notwithstanding the fact that it has the buccal arrangements of a typical *Lumbricus*. In colour and in the disposition of the setæ it somewhat closely resembles *Lumbricus purpureus*, Eisen, but there the resemblances end. The true *Lumbricus* has always six girdle segments, in this worm there are eight or nine. In *Lumbricus* the *tubercula pubertatis* stretch across the four inner segments of the girdle, here they are absent, or if present their position is abnormal. In *Lumbricus* there are two pairs of spermathecae, in this worm they are entirely wanting. *Lumbricus* emits no yellow fluid; this species does, though not always. *Lumbricus* is a true earthworm, this is as truly dendrobænic. Surely these are characters which cannot be ignored, and show conclusively that the mere shape of the prostomium is an insufficient generic character unless accompanied by others which are permanent.

We are now in a position to consider the several British species of the subgenus *Dendrobæna* which have so far been observed and described.

Genus ALLOLOBOPHORA, § DENDROBÆNA = Group No. 3 of  
Rosa's Classification.

1. A. (DENDROBÆNA) *CELTICA*, Rosa. (Pl. XXI. figs. 8, 9.)

Prostomium only partially dovetailed into the peristomium. Individual setæ somewhat widely separated. Length 1 to 1½ inches, of a dark brown or violaceous colour dorsally, tending to iridescence; lighter on the ventral side. Clitellum flesh-coloured, dirty yellow, or grey, and depending considerably on the habitat, occupying 6 segments (31–36); *tubercula pubertatis* on 33–34. Male pore on segment 15, borne on papillæ which extend to segments 14 and 16. In adult specimens segments 9, 25, and 26 also have glandular tumidities or papillæ. First dorsal pore between 5 and 6. Copulatory setæ on segments 31, 32, 35. About 100 segments.

Synonym: *Allolobophora celtica*, Rosa, Boll. Mus. Zool. Torino, 1886.

Found under bark of decaying trees, among dead leaves, or under vegetable mould. Scotland:—Dumfriesshire (Langholm, 1890); Lanarkshire (Paisley, 1892). England:—Devonshire (Bovey Tracey, 1890); Gloucestershire (Painswick, Mr. Watkins, 1891); Yorkshire (Idle, 1891); Kent (Tunbridge Wells, 1892); Northants (Brackley, Mr. Blaby, 1892); Sussex (Dallington, 1892); Lancashire (Morecambe, 1892). Continental records:—Brittany (Brest, Dr. Rosa, 1886); Italy (Rosa, 1887).

2. A. (DENDROBÆNA) BOECKII, *Eisen*. (Pl. XXI. fig. 2.)

This worm has rarely been taken in England. I have, in fact, up till the present only three absolutely reliable records. The species is well-defined, but there has been in the past endless confusion owing to the supposed connection between it and *Lumbricus puter*, Hoffmeister. Eisen's description is very brief, and I therefore describe the species from my own material.

Prostomium more deeply imbedded in the peristomium than in the last species. Male pore on segment 15, on somewhat prominent papillæ. First dorsal pore large, between segments 5 and 6. Girdle of 5 segments normally, covering 29–33, with *tubercula pubertatis* on (30), 31, 32, 33 (Rosa and Eisen give 31, 32, 33, but one of my specimens was as described). Anal segment somewhat pear-shaped. Length about  $1\frac{1}{2}$  inches (Rosa gives 25–35 millim. for specimens in spirits). Total number of segments 80–100. Colour reddish brown, with red clitellum and light, flesh-coloured ventral surface. Setæ in 8 almost equidistant rows. Although Eisen and many others have regarded *Lumbricus puter*, Hoffm., as corresponding with this species, my examination of the subject negatives the idea\*, and I have no hesitation in referring Hoffmeister's worm to Eisen's *Allolobophora subrubicunda*—a worm which is far more widely distributed than *D. Boeckii*, and one which has been mistaken for the latter by many authors. I regard this species as being without synonyms, and take Eisen's description as the original account of a new species as well as a new genus. This worm is so much like *Lumbricus purpureus*, Eisen, that it might easily pass as a true *Lumbricus*. We may compare also *L. melibæus*, Rosa.

\* I am glad to find myself supported in this view by so reliable an authority as Dr. Rosa, of Turin.

Found in similar haunts to those chosen by the last species. England :—Yorkshire (between Bolton Abbey and The Strid, July 1891; Apperley, 1892). Scotland (Paisley, 1892). Continental records :—Norway, Prof. Boeck (after whom the species is named: *cf.* Eisen in *Œfver. af K. Vet.-Akad.* 1873, no. 8, pp. 53-54). Italy (Rosa, *Lumb. del Piemonte*, p. 48).

3. A. (DENDROBÆNA) SUBRUBICUNDA, *Eisen.* (Pl. XXI. fig. 4.)

A well-defined species, and more widely distributed than any of the other dendrobænic forms. It often occurs by scores and hundreds in the midst of vegetable debris on the banks of Yorkshire and other streams, and is easily recognized. It is the largest and in point of size the most variable species of the group, and is more frequently found away from trees than the others.

Eisen described it in 1873 as a new species, but I am convinced that this is the *Lumbricus puter* of Hoffmeister, and must be identical with many of the worms which are now reckoned as synonymous with this. Eisen's description is clear and full, so far as external characters are concerned, and a slightly modified translation, to meet our methods of notation, will exactly suit our indigenous species.

Body cylindrical, somewhat depressed anteriorly and attenuated posteriorly, flattened on the under surface. Prostomium large and pallid, dividing the peristomium to about one half its diameter. Girdle large and conspicuous, of a dull grey colour, and usually covering six or seven segments, 25, 26-31. On each side of the girdle ventrally, and covering segments 28, 29, 30, is a band which constitutes the *tubercula pubertatis*. Setæ in distant couples, not close together as in *Lumbricus*, or slightly separated as in the Brandling. Total number of segments about 90 or 100, length averaging 90 millim.

I may add that the colour is rosy red, with somewhat lighter under surface. Setæ on pale glands, which arrangement makes them conspicuous. Spermathecæ opening in the line of the dorsal setæ (*Rosa*).

A tender delicate worm, well adapted for bait. It is largely employed by anglers in England, under the name of the Cockspur or Gilt-tail; the latter name being derived from the colour of the anal extremity. When a drop of methylated spirit is placed upon the living worm it exudes a yellow fluid, and this may be readily observed flowing from the dorsal pores, the first of which

occurs, as Ude has correctly pointed out, between segments 5 and 6. Spermathecæ are found in the 10th segment, which open in intersegment 9/10 in the direction of the superior pair of setæ.

Eisen gives full directions for distinguishing between this species and the Brandling (*Allolobophora fætida*, Sav.); but if examined in a living condition, these instructions are absolutely unnecessary. Benham is in error\* when he says *A. subrubicunda* is destitute of spermathecæ and *tubercula pubertatis*.

Synonyms: *Allolobophora subrubicunda*, Eisen (*op. cit.* p. 51). *Lumbricus puter*, Hoffmeister, 1845; *Dendrobæna puter* (Ærley, 'A Mag. Olig. Faunája,' 1880, p. 586). Ærley has rightly identified the worm, but did not recognize that it was the same as Eisen's *subrubicunda*. He, however, doubted the accuracy of assigning *L. puter*, Hoffm., to *D. Boeckii*, Eisen. To this species, and not to *D. Boeckii*, Eisen, as Rosa suggests, we must, I think, relegate the *Enterion octaedrum*, Savigny, and perhaps also *A. Fraissei*, Ærley.

Widely distributed both in England and abroad. Among British localities I may mention Yorkshire, Gloucestershire, Devonshire, Northants, Hertfordshire, Middlesex, Essex, Kent, and Sussex. It is recorded also for Siberia, Russia, Sweden, Italy, Hungary, &c.

#### 4. A. (DENDROBÆNA) CONSTRICTA, Rosa.

During a visit to the south of England in the spring of this year I had the good fortune to find a new British species of dendrobænic worm, which, for want of a popular name, I designate the Narrow-ring Worm (*A. constricta*, Rosa). As it corresponds entirely with Rosa's description, which has never been printed in English, I give a translation of the original†. The medium length of this species is about 25 millim.; while it may extend to 45 when living, in alcohol it is usually nearer 20 millim. The number of segments, which are closely compressed, is about 90 to 100. The form is cylindrical, with a gradual attenuation of the two extremities. The girdle is swollen, and when the animal is contracted assumes a globose shape. The colour is fundamentally a transparent flesh- or rose-red. The intestine may be seen in the parts which are less pigmented—the colouring-matter being (as frequently in the Gilt-tail, which

\* 'Attempt to Classify Earthworms,' Q. J. M. S. xxxi. p. 260.

† 'Il Lumbrici del Piemonte,' 1884, pp. 38-9.



it very closely resembles) disposed in bundles alternating with the intersegmental groove. The prostomium dovetails into the first segment to about two thirds of its diameter. The male pores are easily seen on the white papillæ of the 15th segment. The girdle is constant upon segments 26 to 31, but there are no bands (*tubercula pubertatis*). The setæ are disposed in wide pairs or nearly equidistant rows. The worm is very active, as indeed are most of the group, and like the others it emits a yellow inodorous fluid. It is distinguished from the Gilt-tail by the greater number of segments compressed into the same length, and the absence of the band. There are no synonyms, and its known distribution is Italy (Ceres and Rosazza) and England (Dallington, Sussex).

5. A. (DENDROBÆNA) ARBOREA, *Eisen*. (Pl. XXI. fig. 3.)

This diminutive worm was first described by Eisen in 1873. It appears to have been as entirely overlooked up till that date as the last-named species was till eight years ago; and I have little doubt but that in future years, when the decaying forest trees of other lands come to be explored, we shall find several other species which up till the present time have passed altogether unobserved. The description of Eisen is true of our native species. Body cylindrical, prostomium large and pale, occupying about one half of the first segment. Male pores on segment 15 tumid and conspicuous. Girdle for the most part composed of six segments extending over 26-31. *Tubercula pubertatis* on the 14th and 15th segments behind the male pore, *i. e.* on segments 29, 30. The anal segment somewhat exceeds that which precedes it in length. The setæ are everywhere in distant pairs. Segments 50-60 (sometimes more in British specimens); length about 50 millim. (not so great in my British specimens). First dorsal pore between 5 and 6. Like *Dendrobæna Boeckii* (says Eisen), this species is found in old stumps of trees, into which, however, it penetrates further than the latter species. The specimens sent me from Gloucestershire were found deep in the wood, while two other species (*A. celtica* and *A. Eiseni*) were found in the same stump less deeply imbedded. Eisen examined one specimen in which the *tubercula pubertatis* extended over segments 28-31. At first sight the species resembles *D. Boeckii*, remarks Eisen, and it is marvellous that he should found a genus for tree-haunting worms, and exclude from it his own *arborea*.

Synonym: *Allolobophora arborea*, Eisen (Om Skand. Lumb. 1873).

English records:—Gloucester (Painswick, Mr. Watkins, 1892); Sussex (Dallington, 1892); Yorkshire (Esholt, 1891); Norfolk (Norwich, Mr. A. Mayfield, 1892). On the Continent Eisen records its occurrence in "Skåne, Vestergötland och Valders i Norge." He refers to it as the rarest of Swedish worms. I cannot find any record up till the present date for Germany, Italy, or Hungary. Dr. Rosa seems not to have met with it.

6. A. (DENDROBÆNA) EISENI, *Levinsen*. (Pl. XXI. figs. 7, 10.)

Hitherto this worm has happily passed through the hands of systematists invariably as *Lumbricus Eiseni*, *Levinsen*; but the time has come when it must be removed from the false position it has occupied undisturbed till the present. It must, however, be admitted that it does not fit in with the genus *Allolobophora*, though it belongs to this place as a true tree-worm.

The worm is small, cylindrical, slightly attenuated, usually about an inch, or at most an inch and a half, in length, *i. e.* 30 to 40 millim. Its prostomium, like that of the true *Lumbricus*, forms with the peristomium a perfect mortise and tenon. It often closely resembles the typical *Lumbricus* in colour, being a warm brown, frequently with iridescence, and has the setæ in couples somewhat close together. These are its only affinities in that direction. It lives in old trunks of trees and among decaying timber or woodland debris, is small, destitute of the two pairs of spermathecae which every true *Lumbricus* possesses, and in the matter of *clitellum* and its accessories is separated very widely from that genus.

The girdle covers eight segments, extending from 24 to 31; total number of segments 90–110. There are no *tubercula pubertatis*; the male pore on segment 15 is on papillæ slightly developed, and the first dorsal pore is between 5 and 6. The constancy of this feature in the dendrobænic group is striking. Rosa submitted specimens exactly answering this description to *Levinsen*, who stated that they were identical with his *Lumbricus Eiseni*\*. The original specimens from Copenhagen were taken, according to Rosa's translation of *Levinsen*'s account, from old trees, and my English specimens have been obtained from similar habitats.

\* Bolletino Mus. Zool. ed. Anat. 1887, 1889.

Synonym: *Lumbricus Eiseni*, Levinsen (Syst. geogr. Oversigt over de nord. ann. &c., Copenhagen, 1883).

Found in the following localities in England:—Cumberland (Carlisle, 1890); Gloucestershire (Painswick, Mr. Watkins, 1892, *see* 'Nature,' February 18th, 1892); Sussex (Dallington, March 1892); Epping Forest. The Continental records are Copenhagen, Azores?, Piedmont, and Rivarossa.

We are now prepared for a survey of the principal characteristics of the group.

#### § DENDROBENA, *Eisen*.

Small tender worms, from 1 to  $2\frac{1}{2}$  inches in length, found in decaying trees, among dead leaves, and rotten vegetable matter; sometimes wandering to other habitats. Colour usually brown, rose-red, or flesh, with dull clitellum and lighter under surface. Prostomium more or less deeply imbedded in the peristomium, which is without setæ. Setæ always in eight rows or in four couples, more or less distant, making the body appear rectangular.

Girdle occupying five to eight segments, commencing somewhere between the 24th and 31st.

Male or spermiducal pores on segment 15, usually with prominent papillæ, which sometimes extend over the two adjoining segments.

*Tubercula pubertatis* in two or three pairs on consecutive segments; not observed in one species.

First dorsal pore usually between segments 5 and 6. Spermatophores between the male pore and the clitellum.

The internal characters have not yet been made out with sufficient accuracy by any investigator to allow of classification. Spermathecæ are present in some species, but absent from others. When present they open in the direction of the superior pair of setæ (*Rosa*).

Usually secreting a small quantity of yellow fluid from the dorsal pores.

The accompanying table (p. 304) supplies in concise form the principal distinguishing features of this interesting group of worms.

*Tabular View of British Alloobophoræ.*

§ DENDROBENA.

Name.	Clitellum occupies	Tubercula pubertatis.	First Dorsal Pore.	Total segments.	Length.	Colour.	Prostomium imbedded.	Setæ.
1. <i>celtica</i> , Rosa .....	31-33	33, 34	5/6 ?	90-110	1-1½ in.	Brown or Rose-red.	Partially.	4 pairs wide.
2. <i>Boeckii</i> , Eisen .....	29-33	31, 32, 33	5/6	90-100	1-1½ in.	Red-brown.	Two thirds.	8 rows.
3. <i>subrubicunda</i> , Eisen ...	25-31	28, 29, 30	5/6	100-120	1½-2½ in.	Rose-red.	Partially.	4 pairs separated.
4. <i>constricta</i> , Rosa .....	26-31	0	5/6	90-100	1 in.	Rose-red.	Two thirds.	4 pairs separated.
5. <i>arborea</i> , Eisen .....	26-31	29, 30	5/6	50-80	1 in.	Rose-red.	Slightly.	4 pairs wide.
6. <i>Eiseni</i> , Levinson .....	24-31	0	5/6	90-110	1½ in.	Red-brown iridescent.	Completely.	4 pairs close.

## II. ON A NEW SPECIES OF LUMBRICUS.

During the summer of 1890 I collected a large series of Earthworms, with the intention of drawing up a complete catalogue of all the species to be found in Yorkshire, where I was residing. The material thus obtained was passed under rapid review, and then put aside till I should be able to command sufficient leisure for a more detailed examination.

Among the specimens taken in the immediate neighbourhood of my residence I observed some worms which I was unable to correlate with any one of the species known as British, and as I extended my investigations it became more and more apparent that I had alighted on a species which was not only new to Britain, but one which was also unknown to science.

Having recently had occasion to devote some time to the more thorough and exhaustive examination of our worm-fauna, and having at the same time discovered my new species in several parts of the country, I purpose in this paper, not only submitting a detailed account of the worm in question, but showing how we stand at present in relation to the genus as a whole. For some years past I have been working persistently at the family Lumbricidæ, to which all our indigenous earthworms belong, and now feel that I am in a position to deal with the different genera in a fuller manner than has been possible with any previous writer on British earthworms.

It seems desirable in the first place to give a diagnosis of the external characters of the species, to which, for reasons to be assigned hereafter, I have given the name *rubescens*. Internally, so far as my examination has proceeded, there is no new or abnormal feature to record, the worm answering in all respects to the typical *Lumbricus*. In the matter of terminology I shall follow Eisen, who was the first to distinguish *Lumbricus* from *Allolobophora*.

LUMBRICUS RUBESCENS, sp. nov.

*Corpus* elongatum aut crassum, antice cylindricum, attenuatum, postice depressum.

*Lobus cephalicus* (sive prostomium) magnus, antice rotundatus, supra in medio sulco transverso præditus; postice segmentum buccale (id est peristomium) in duas partes dividens; infra pallidus, sulco longitudinali furcato.

*Tubercula ventralia* plerumque conspicua in segmento 15.

*Cingulum* prominens, e sex segmentis (34-39) semper confectum; infra duobus parallelis tuberculis, in segm. 35, 36, 37, 38.

*Setæ* binæ approximatae.

*Segmenta* circa 100-120.

*Longitudo* circa 10 cm.

*Prima foramen dorsi* inter segmenta 5-6.

Like the other true species of *Lumbricus*, this worm is anteriorly of a purplish-brown colour, iridescent, especially on the dorsal surface, and lighter along the hinder quarter as well as ventrally. The colour of the girdle or clitellum is a warm brown, corresponding closely to that of the posterior extremity, but somewhat darker than the ventral surface of the worm's body. The prostomium or cephalic lobe forms a perfect "mortise and tenon" with the first or buccal segment, which is, as usual, without setæ.

The term "mortise and tenon" is a much more accurate one than "dovetail," which Benham employs. The latter is the more appropriate term, however, for the species of *Allolobophora*. It may be here pointed out that every known species of *Lumbricus* is distinguished from all other species of British worms by the presence of an iridescent purple-brown colour, inseparable from the "mortise and tenon" arrangement of the anterior extremity, and coupled with a girdle of six segments, *tubercula pubertatis* forming a band across the inner four, setæ in four closely approximated couples, and the ability to secrete a slimy mucus, but not a turbid liquid. Internally there are two pairs of spermathecæ and three pairs of sperm-sacs. As I have already pointed out\*, the so-called *Lumbricus Eiseni*, Levinsen, is not a true *Lumbricus*, although it resembles that genus of worms in one or two particulars.

In shape and size this species is exactly intermediate between the common earthworm (*L. terrestris*, L.), as defined hereafter, and the red worm (*L. rubellus*, Hoffm.). It may in fact be readily confounded with the latter at first sight, just as the red and purple worms were, till Eisen pointed out their distinctive characters. The setæ are always in couples, the individuals of which are nearly close together, while each couple is separated by a moderate interval from the next, as in each of the other species.

\* "On the Tree-worms of Great Britain," *supra*, p. 302.

The male pores, known to Eisen as *tubercula ventralia*, and termed spermiducal pores by Benham, are situated on segment 15, and are borne upon prominent papillæ. In this respect the worm corresponds with our common earthworm (*L. terrestris*, L.) and with the Continental *L. melibœus*, Rosa, but differs from our other native species. Rosa terms these papillæ atria; but Beddard, as I have stated already, demurs somewhat to the use of the designation. In the purple worm (*L. purpureus*, Eisen) and the red worm (*L. rubellus*, Hoffm.) the papillæ are totally wanting, and the 15th segment is destitute of every feature indicating its importance in the sexual relationship. As a consequence the pores cannot be distinguished as a rule, even with a lens. As we find a pair of tumid projections on the adult earthworm (*L. terrestris*) under segment 26, so in this species we have a pair of papillæ on the ventral surface of the 28th and 29th (or 29th and 30th) segments. This posterior position corresponds with that of the clitellum, which commences on segment 32 in the common earthworm, but on 34 in the new species.

Although it is much easier to determine the species of a worm when adult than when immature, just as an umbelliferous plant can be more readily determined when in fruit than when bursting into flower, yet in the present instance there is an advantage in the case of the immature specimens over those of other species, on account of the very prominent copulatory setæ found on segments 10, 12, 29, 33–40. The clitellum extends from the 34th to the 39th segments, but the two adjoining somites usually bear copulatory setæ as well, a fact which seems to indicate that the girdle formerly occupied eight instead of six segments. This point is of value when we remember that in *Allolobophora* the clitellum is frequently found to cover eight segments, which is also the normal number in *L. Eiseni*, Lev. The *tubercula pubertatis* form a distinct band on either side of segments 35–38, and this striking case of uniformity in each of our British species affords one good reason for excluding from the genus such aberrant forms as *Lumbricus Eiseni*, Levinsen, and some others which have been classed as *Lumbrici*. In every genuine *Lumbricus* the girdle occupies six segments, while the *tubercula pubertatis* form a band along the four middle segments. I have examined thousands of specimens, and in every normally developed adult have found this rule to hold good. I cannot insist too strongly on this point as an important key to classification. If a worm is found with

seven or eight girdle-segments, and the *tubercula pubertatis* occupy alternate segments, or are found as pores on two or three segments on the posterior portion of the girdle, it cannot be a true *Lumbricus*. On the other hand, an *Allolobophora* may have six girdle segments and four *tubercula pubertatis*, as, e. g., in *A. profuga*, Rosa.

The segments in this species are not as a rule strongly annulated, or divided into rings; but even in the closely-related species, which are said by some authors to be always bi- or tri-annulate, I have found great diversity. The first dorsal pore is situated between segments 5 and 6. Notwithstanding Ude's careful researches, I am a little in doubt about the constancy of the first dorsal pore, and am of opinion that its position varies with the age of the worm, at least in some species. I have discovered that these pores are not only valuable on account of their close connection with the dorsal vessel, to which they afford the necessary oxygenation, but also on account of their connection with the glands employed in secreting mucus and protective fluids \*. If one of the worms which exude a yellow fluid containing a considerable proportion of solid matter is held in such a position that its pores can be seen while a drop of spirit is placed on its body the coloured matter will at once be seen to stream forth from the pores in a very striking manner, and, as a rule, the first pore can instantly be detected by this means.

Internally *L. rubescens* has the normal number and arrangement of the various organs. There are two pairs of spermathecae in segments 9 and 10, the gizzard occupies the 17th and 18th segments, and the cesophageal or calciferous glands are in segments 11 and 12. There are three pairs of sperm-sacs, or *vesiculæ seminales*, in segments 9, 11, and 12, and the usual arrangement of pharynx, nephridia, and other organs.

I have adopted the specific name of this worm first of all because it is as near the truth respecting the colour of the animal as either *rubellus* or *purpureus*. In fact, the whole of this group of worms so exactly resemble each other in this respect that any name drawn from, or applied to, their coloration must be vague at best. This name, however, commends itself to me on the ground that it has already been assigned to a British earth-worm which was never properly described. I have therefore

\* Rosa especially has called attention to this and other important points.



assumed the identity of the two worms and utilized the nomenclature in order to avoid adding another to the bewildering list of names already in use.

Templeton, years ago, found a worm "common in rich grounds, generally where docks grow," which he describes in the following terms:—"Body long, contractile, cylindrical, with a compressed lanceolate apex [posterior], unfurnished with a belt at the position of the sexual organs. Each ring with very small spines projecting backwards."

When I first discovered the species I have been describing the girdle was still undeveloped, though the region it was to occupy was well defined and slightly lighter in colour. It corresponded so exactly with Templeton's further account that I concluded he must have seen the same worm. He adds:—"It is never larger than half the size of *L. terrestris*; and is of a bright reddish-brown, with the hinder part, or apex, very flat."

The characters will be summarized when we come to survey the genus with a view to the better understanding of the various species found in Great Britain.

*Lumbricus rubescens* was first discovered between Idle and Eccleshill, near Bradford, Yorks, in 1890. During the present year (1892) I have taken it freely at Dallington, in Sussex (March 28th), while I obtained one specimen near a little gutter on the Common at Tunbridge Wells, Kent (March 26th), and another at Hornsey, in Middlesex (March 31st). I have also received specimens from Avonmouth, Norwich, and Paisley. The Dallington specimens were obtained by shaking the ground in a sheltered meadow with a gardening fork, when they came out in fine condition. On one of these specimens I found a pair of spermatophores attached to the ventral surface of segment 32, and differing in shape and appearance from those so accurately figured by Vejdovsky as found on the Green Worm (*Allolobophora chlorotica*). The total number of segments is about 120, the worm being usually from 3 to 4 inches in length. It is exceedingly active, and is usually found along with the Red Worm (*L. rubellus*, Hoffm.), with which it may be easily confounded, and with which I have also found it in copulation.

*Synonyms*.—Assuming the identity of this species with the one referred to above, the synonyms are *Lumbricus omilurus* = *Omilurus rubescens*, Templeton, Loudon's Mag. Nat. Hist. ix. p. 235 (*fide* Johnston, 'A Catalogue of British Worms,' 1865, p. 63).

Dr. Rosa has called my attention to the fact that a worm was imperfectly described some years ago under the name of *L. festivus*, Savigny, in which the girdle segments occupy the same position as that indicated for *L. rubescens*, Friend. The other characters, however, are too little known to justify the inclusion of the name here.

As by the discovery of this worm a slight alteration in the generic characters of *Lumbricus* is made necessary, I shall here, in the first place, emend the recently-published analysis of Benham\*, and then describe the different species at present known to occur indigenously in Great Britain. A list of synonyms may then very properly be appended. The revision relates only to our native species, but will apply to those found abroad as well.

*A Revision of the Genus Lumbricus, Linn.*

Prostomium forming with the peristomium a perfect "mortise and tenon."

Setæ 8 in each segment, always in couples, the individuals of which are in close proximity. Those on the clitellum, and on certain other segments, differing by their greater length, never ornamented.

Clitellum always composed of six segments, commencing somewhere between segments 26 and 34.

Male or spermiducal pores on segment 15, either with or without papillæ.

Sperm-sacs, or vesiculæ seminales, three pairs in segments 9, 11, 12, connected across the middle line by sacs enclosing the testes and ciliated rosettes. Testes in segments 10, 11, ovaries in segment 13.

Spermathecæ in segments 9 and 10, two pairs opening posteriorly.

Gizzard in segments 17-18.

Calciferous or cesophageal glands in segments 11, 12.

Nephridia simple, meganephric, in pairs in each segment except the most anterior.

Tubercula pubertatis, four on each side, forming a band along, or near to, the ventral limit of the clitellum, omitting the first and last segments.

\* "An Attempt to classify Earthworms," in Q. J. M. S. vol. xxxi. 1890, pt. ii. pp. 258-9.

Colour purplish or ruddy brown with iridescence, paler ventrally, and with the clitellum lighter than the anterior portion.

Form cylindrical, more or less flattened posteriorly.

First dorsal pore may begin between segments 5 and 6 or posteriorly to this.

Nephridiopore in a line with the inner couple of setæ.

Anus terminal.

Spermatophores, in the breeding-season, attached to the body between the male pores and the hinder extremity of the clitellum.

Body often covered with mucus, never exuding a coloured, granulated fluid.

### *British Species of Lumbricus.*

#### 1. LUMBRICUS TERRESTRIS, Linn.

The largest indigenous species. Regarded as very common, but in most cases confounded with one or other of the Lumbricoid *Allolobophoras*, especially *Allolobophora longa*, Ude, which is much more common and widely distributed.

The internal structure is normal. It is usually 4 to 6 inches or more in length; of a warm brown colour, iridescent. The male pores are easily seen, owing to pale-coloured papillæ on segment 15. The girdle always extends from the 32nd to the 37th segment in the typical species. This point must be emphasized to avoid further confusion. *Tubercula pubertatis* forming a band on segments 33, 34, 35, 36. Tail flattened; setæ in four double rows. First dorsal pore between segments 8/9 (*Ude*). Copulatory setæ on papillæ on segment 26.

Synonyms numerous. The distribution has been only partially worked out, owing to confusion in former identifications. I retain the name given to the earthworm by Linnæus because the other worms which were confounded with it have now all been removed to the genus *Allolobophora*, so that there is no need to alter the original designation.

The subject of the possible hybridization of this species with other species of *Lumbricus* or *Allolobophora* has hitherto received too little attention\*. Some so-called varieties are now known to be true species, and will be found among the separated genus.

#### 2. LUMBRICUS RUBESCENS, Friend. (Pl. XXI. fig. 12.)

Next in size to the foregoing, and intermediate between it and the following. Similar in colour, shape, and the arrangement of

\* See an article on this subject in 'Field Club,' 1892.

the parts. Male pores on prominent papillæ on segment 15. Readily identified by the backward position of the girdle, which covers segments 34 to 39. *Tubercula pubertatis* on 35, 36, 37, 38, forming a band along the clitellum omitting the first and last segments. First dorsal pore between segments 5 and 6, thus filling up a gap in the series as shown in the following table. Copulatory setæ on segments 29, 30, as well as on the under surface of the clitellum. Spermatophores transparent sacs attached to the ventral surface in front of the clitellum.

Distribution, so far as at present known, Scotland to Gloucestershire and Sussex; at present peculiar to Great Britain, unless *L. festivus*, Savigny, should prove to be the same. This worm has, however, been observed by no recent investigator on the Continent.

### 3. LUMBRICUS RUBELLUS, *Hoffmeister*.

Somewhat smaller than the foregoing. Usually about 3 inches in length, purple, with brick-red clitellum, which is very prominent in the adult worm, and extends from the 27th to the 32nd segments. Eisen has rightly pointed out that occasionally the girdle is shifted bodily one segment forward (26 to 31), but this is of rare occurrence in Great Britain. The male pores cannot be detected on segment 15, even with a lens, but when the worm is adult a band connects it with the girdle. The first dorsal pore is between segments 7 and 8.

It is widely distributed both at home and abroad, and has not received so many aliases as most species have. It was first distinguished as a species by Hoffmeister in 1845. Erley, owing to his error in the identification of *Lumbricus terrestris*, L., revived Savigny's name *Enterion* for this and the next species. Hoffmeister's designation, however, has undisputed right to be retained.

I have found this species at times with a very limited number of post-clitellian segments, causing the worm to assume a very characteristic appearance (var. *curticaudatus*, Friend); I have, however, failed so far to determine whether the effect is due to soil, height above sea-level, want of proper food, or otherwise.

### 4. LUMBRICUS PURPUREUS, *Eisen*. (Pl. XXI. fig. 11.)

The smallest of our true *Lumbrici*, usually measuring about 2 inches in length. It is, however, very variable in size: some-

times approaching the preceding, at other times becoming quite diminutive. The girdle is situated on segments 28 to 33, the *tubercula pubertatis* forming the usual band on segments 29 to 32. The first dorsal pore is between 6 and 7. This, like the last, may often be found in certain localities with a very short tail, so that the girdle appears right in the middle of the body. The male pore may sometimes be distinguished, though there are no papillæ. It breeds freely under clots of dung in pastures, and is a most valuable scavenger. It is as widely distributed as the last.

Though Eisen gave it the name which it now bears in 1870, it was already known to science, having been described in 1829, and known as *Enterion castaneum*, Savigny, or *L. castaneus*, Dugès, on account of its chestnut colour. So far as my researches have gone this species occurs at a greater altitude in Great Britain than either of the other three species. It is usually a good deal larger south of the Thames than north of the Solway.

The Continental *Lumbricus melibæus*, Rosa, has not yet been found in Great Britain; of *Lumbricus caucasicus*, Kulagin, reported to occur in South Russia, I know nothing. *Lumbricus Eiseni*, Levinsen, as I have shown elsewhere, is an aberrant species, and though found in several places in England, is more naturally ranked with the *Dendrobænas*. These are the only species which at present claim to be genuine European Lumbrici, so that out of the six possible species four are indigenous to this Island, one of which appears so far to be peculiar to Britain.

The following table (p. 314) will give a bird's-eye view of the genus so far as our present knowledge goes.

*A Revised Synonymy of British Worms.*

<i>Lumbricus agilis</i> , Hoffm.	=	<i>Allurus tetraedrus</i> , Eisen.
„ <i>agricola</i> , Hoffm.	=	<i>Lumbricus terrestris</i> , Linn.
„ <i>amphisbæna</i> , Dugès	=	<i>Allurus amphisbæna</i> (Dugès).
„ <i>anatomicus</i> , Grube	=	{ <i>Allolobophora turgida</i> , Eisen.
„ <i>anatomicus</i> , Dugès	=	{ <i>Allolobophora mucosa</i> , Eisen.
„ <i>annularis</i> , Temp.	=	<i>Allolobophora riparia</i> , Hoffm.
„ <i>calignosus</i> , Dugès	=	<i>Allolobophora riparia</i> , Hoffm.
„ <i>carneus</i> , Hoffm.	=	{ <i>Allolobophora mucosa</i> , Eisen.
„ <i>chloroticus</i> , Grube	=	<i>Allolobophora riparia</i> , Hoffm.
„ <i>ciliatus</i> , Müller	=	<i>Valla ciliata</i> , Johnston.
„ <i>castaneus</i> , Sav.	=	<i>Lumbricus purpureus</i> , Eisen.
„ <i>communis</i> , Hoffm.	=	{ <i>Allolobophora mucosa</i> , Eisen.
		{ <i>Allolobophora turgida</i> , Eisen.

*A Tabular View of the Genus Lumbricus (Linn.).*

<i>Lumbricus.</i>	Segments occupied by						Total number of segments.	Average length.	When described.
	Girdle.	Tub. pub.	1st pore.	Male pore.	Papillæ.				
<i>terrestris</i> , L. ....	32-37	33-36	8/9	15†	26		150-200	5 in.	1757
<i>rubescens</i> , Friend .....	34-39	35-38	5/6	15†	28		100-130	4 in.	1892
<i>rubellus</i> , Hoffmeister ...	27-32	28-31	7/8	15	0		100-120	3 in.	1845
<i>purpureus</i> , Eisen .....	28-33	29-32	6/7	15	10		80-100	2 in.	(1829) 1870
<i>melibæus</i> , Rosa .....	29-33	30-33	7/8	15†	?		110-125	3 in.	1884

† Indicates the presence of papillæ (Rosa's so-called atria).

<i>Lumbricus complanatus</i> , <i>Dugès</i>	=	<i>Allolobophora complanata</i> , <i>Dugès</i> .
„ <i>cyaneus</i> , <i>Hoffm.</i>	=	<i>Allolobophora turgida</i> , <i>Eisen</i> .
„ <i>Eiseni</i> , <i>Levinsen</i>	=	<i>A. (Dendrobæna) Eiseni</i> , <i>Levinsen</i> .
„ <i>foetidus</i> , <i>Savigny</i>	=	<i>Allolobophora foetida</i> , <i>Savigny</i> .
„ <i>gordianus</i> , <i>Temp.</i>	=	<i>Allolobophora turgida</i> , <i>Eisen</i> .
„ <i>herculeus</i> , <i>Sav.</i>	=	<i>Lumbricus terrestris</i> , <i>Linn.</i>
„ <i>lividus</i> , <i>Temp.</i>	=	<i>Allolobophora turgida</i> , <i>Eisen</i> .
„ <i>major</i> , <i>Mouf.</i>	=	} <i>Lumbricus terrestris</i> , <i>Linn.</i>
„ <i>maximus</i> , <i>Leach</i>	=	
„ <i>minor</i> , <i>Johns.</i>	=	<i>Lumbricus purpureus</i> , <i>Eisen</i> .
„ <i>multispinus</i> , <i>Grube</i>	=	<i>Euchytræus albidus</i> , <i>Henle</i> .
„ <i>octaedrus</i> , <i>Sav.</i>	=	<i>Allolobophora subrubicunda</i> , <i>Eisen</i> .
„ <i>olidus</i> , <i>Hoffm.</i>	=	<i>Allolobophora foetida</i> , <i>Eisen</i> .
„ <i>omilurus</i> , <i>Temp.</i>	=	<i>Lumbricus rubescens</i> , <i>Friend</i> .
„ <i>pulchellus</i> , <i>Leach</i>	=	<i>Lumbricus purpureus</i> , <i>Eisen</i> .
„ <i>puter</i> , <i>Hoffm.</i>	=	<i>Allolobophora subrubicunda</i> , <i>Eisen</i> .
„ <i>riparius</i> , <i>Hoffm.</i>	=	<i>Allolobophora riparia</i> , <i>Hoffm.</i>
„ <i>rufescens</i> , <i>Johnst.</i>	=	<i>Lumbricus rubescens</i> , <i>Friend</i> .
„ <i>terrester</i> , <i>Grube</i>	=	<i>Lumbricus terrestris</i> , <i>Linn.</i>
„ <i>tetraëdrus</i> , <i>Dugès</i>	=	<i>Allurus tetraedrus</i> , <i>Eisen</i> .
„ <i>trapezoideus</i> , <i>Dugès</i>	=	<i>Allolobophora trapezoidea</i> , <i>Dugès</i> .
„ <i>virescens</i> , <i>Sav.</i>	=	} <i>Allolobophora riparia</i> , <i>Hoffm.</i>
„ <i>viridus</i> , <i>Johnst.</i>	=	
„ <i>xanthurus</i> , <i>Temp.</i>	=	<i>Allolobophora subrubicunda</i> , <i>Eisen</i> .

## EXPLANATION OF PLATE XXI.

Fig. 1. Typical tree-worm.

2. Girdle and band of *Allolobophora* (§ *Dendrobæna*) *Boeckii*, *Eisen*.
3. Girdle and band of *A.* (§ *Dendrobæna*) *arborea*, *Eisen*.
4. Girdle and band of *A.* (§ *Dendrobæna*) *subrubicunda*, *Eisen*.
5. Distribution of setæ (diagram).
6. Head of typical tree-worm.
7. Head of *A.* (§ *Dendrobæna*) *Eiseni*, *Levinsen*.
8. Male pores and papillæ of *A.* (§ *Dendrobæna*) *celtica*, *Rosa*.
9. Girdle and band of the same.
10. Girdle of *A.* (§ *Dendrobæna*) *Eiseni*, *Levinsen*.
11. *Lumbricus purpureus*, *Eisen*.
12. *Lumbricus rubescens*, *Friend*.
13. Head of typical *Lumbricus*.

*cl.*, clitellum or girdle; *m.p.*, male pore; *per.*, peristomium; *pr.*, prostomium; *t.p.*, tubercula pubertatis or band.

The small figures indicate the number of the segment; counting the peristomium as the first. Figs. 1, 11, 12, natural size; all the rest enlarged about 5 diameters. Figs. 2, 3, 4, 9, 10 are lateral views; 6, 7, and 13 are dorsal.

Supplementary Notes on the Arachnida and Myriopoda of the Mergui Archipelago : with Descriptions of some New Species from Siam and Malaysia. By R. I. POCKOCK, of the Natural History Museum. (Communicated by W. PERCY SLADEN, Sec. Linn. Soc.)

[Read 16th June, 1892.]

(PLATE XXII.)

THE specimens which form the subject of the present supplementary note upon the fauna of the Mergui Archipelago, were unfortunately overlooked when Dr. Anderson's collection was originally distributed to the various specialists who have reported upon it.

These specimens were contained in two bottles—one being ticketed Mergui, the other Owen's Island. Something of interest was found in each bottle—two of the Myriopoda from Owen's Island proving to be new species, while several examples of a large Tetrapneumonous spider from Mergui appear to be representatives of a new genus.

## ARACHNIDA.

### Order SCORPIONES.

*PALAMNÆUS SPINIFER* (*Hempr. & Ehrb.*).

*Heterometrus spinifer*, *Hempr. & Ehrb. Symb. Phys. Scorpiones*, p. 3, pl. i. fig. 2 (1829).

*Palamnæus Petersii*, *Thorell, Ann. Mag. Nat. Hist.* (4) xvii. p. 13; *id. Actes Soc. Ital. Sci. Nat.* xix. pp. 214–217 (exclusive of synonymy).

Dr. Anderson obtained this species at Mergui. It is widely distributed in Further India and the Malay Archipelago, having been recorded from many localities between Bengal and Singapore. For a discussion of the above-given synonymy, and for further details respecting distribution, see Pocock, *Ann. Mag. Nat. Hist.*, Jan. 1892, pp. 38–41.

### Order PEDIPALPI.

*HYPOCTONUS FORMOSUS* (*Butler*).

*Thelyphonus formosus*, *Butler, Ann. Mag. Nat. Hist.* (4) x. pp. 203, 204, pl. xiii. fig. 4.

*Thelyphonus angustus*, *Stoliczka, Journ. As. Soc. Bengal*, xlii. p. 134, pl. xii. fig. 3.



*Hypoctonus formosus*, Thorell, *Ann. Mus. Genov.* xxvi. p. 360; *id. loc. cit.* xxvii. pp. 542-553 (1889).

*Thelyphonus insularis*, Oates, *Journ. As. Soc. Bengal*, lviii. (2) p. 13, figs. 7 & 8 (1889).

A single example was obtained on Owen's Island.

The species appears to be tolerably common in the southern parts of Burma. It was originally described from Moulmein, and has subsequently been recorded from Tenasserim and elsewhere. The name *angustus* is included in the above synonymy on the authority of Dr. Thorell and Mr. E. W. Oates. Mr. Oates has kindly presented to the British Museum a large number of specimens of his species *insularis*, which were obtained on Double Island. There can, however, I think be little doubt that these examples are specifically identical with Butler's type of *formosus*.

#### Order ARANEÆ.

##### Fam. EPEIRIDÆ.

*NEPHILA MACULATA* (Fabr.).

*Hab.* Mergui.

##### Fam. THERAPHOSIDÆ.

*SELENOCOSMIA JAVANENSIS* (Walck.).

*Hab.* Mergui. A single female example, giving the following measurements:—Length of body 54 millim., of cephalothorax 23·5; width of cephalothorax 20; length of maxilla and palp 53·5, of 1st leg 81, of 2nd 70, of 3rd 64, of 4th 82·5, of posterior mamilla 14·5; length of sternum 10·2, width 10; length of labium 3·5, width 4.

*ORNITHOCTONUS ANDERSONI*, gen. et sp. nov. (Pl. XXII. figs. 1-3.)

*Colour* a deep coffee-brown, clothed with paler brown hairs.

*Cephalothorax* longer than wide, high in the cephalic region, the anterior third of the upper surface (in the middle line) nearly horizontal, but sloped slightly downwards and forwards, the posterior two thirds sloped upwards at about an angle of 40°; the sides strongly sloped from the middle line. The radiating grooves defined. The fovea conspicuous, linear, transverse. Ocular tubercle well defined, wider than long, separated from the anterior border by a space equal to half its width; the eyes set

almost exactly as in *Selenocosmia javanensis*, but a little closer together.

*Mandibles* similar to, but a little weaker than, those of *Selenocosmia javanensis*, unarmed in front; *maxillæ* also as in that species.

*Palpi* and *legs* shorter and more robust than in *Selenocosmia*; distal tarsal segments scopulate, the proximal tarsal completely scopulate on the first pair, nearly completely on the second, half covered on the third, and with only its distal third so furnished on the fourth. All the scopulæ very large and undivided, except those on the proximal tarsal of the fourth pair of legs, which are in two complete halves. A single sharp black spine on each side of the lower surface of the distal extremity of the tibial segments of each pair of appendages; for the rest the segments are unarmed, except for the two terminal claws. The first leg a little shorter than the fourth.

*Sternum* considerably longer than wide; the *labium* defined behind by a deep groove, nearly twice as wide as long, convex along its free border, and not quadrate.

The *abdomen* rounded or ovate.

The *posterior spinners* short, not so long as the patella of the third pair of legs, and less than a third of the length of the cephalothorax; the segments subequal in length.

*Measurements in millimetres*.—Length of cephalothorax 25·5, width 21, of cephalic portion 13·5; distance of fovea from anterior margin 17; width of ocular tubercle 3·3; length of abdomen 30, width 22, height 19; length of sternum 12·5, width 19; width of labium 3·5, length 2·5; length of appendages (including coxal segments), palp 52·5, 1st leg 74, 2nd 67·5, 3rd 55, 4th 74, length of superior mamilla 7·5.

*Hab.* Mergui. Dr. Anderson obtained several examples of this fine spider. They were discovered beneath large stones, squatting with their egg-cases in shallow excavations of the soil.

According to Simon's recent revision of the Theraphosæ, the genus falls into the tribe *Theraphosæ* of the subfamily *Avicularinæ*. It cannot, however, be confounded with any of the genera of this tribe.

#### EXPLANATION OF PLATE XXII.

- Fig. 1. *Ornithoctonus Andersoni*, gen. et sp. nov.; nat. size, from above.  
2. Lower surface of cephalothorax; nat. size.  
3. Ocular tubercle, enlarged.

## MYRIOPODA CHILOPODA.

## Fam. SCOLOPENDRIDÆ.

## OTOSTIGMA OWENII, sp. n.

*Colour* (in alcohol) a pale olivaceous, the first tergite and head partly ferruginous; anal legs green.

Moderately slender, attenuated anteriorly.

*Head* smooth, only finely punctured; antennæ moderately long, composed of 18–21 segments, the basal three of which are naked. The dental plates of the maxillary coxæ nearly in contact, each armed with four sharp teeth.

The *tergites* obsoletely wrinkled posteriorly, not spicular, from the 6th bisulcate, from the 15th with elevated margins. *Sternites* smooth, not tubercular, only obsoletely impressed at the hinder end of the body, marked in front with two posteriorly abbreviated sulci.

*Anal somite* small, the *tergite* with a conspicuous posterior median impression; the *pleuræ* thickly studded with small, close-set pores, the posterior prolongation short, forming an angle of about  $45^{\circ}$ , furnished with one lateral and three apical spines; *sternite* much narrowed posteriorly, its sides lightly convex, its posterior border emarginate; *legs* long and slender, tarsus unarmed, femur armed with 11 spinules—2 on the upper inner edge (1 terminal and 1 median), 5 in two series on the under inner edge, and 4 in a single series on the under outer edge.

*Legs*, tarsi of 20th unarmed, of 19th armed with one spur, of the rest armed with at least two spurs.

Length 38 millim.

*Hab.* Mergui. A single example from Owen's Island.

The specimen here described I cannot definitely refer to any known species. The genus *Otostigma*, however, is exceedingly difficult to understand; and it is impossible to feel absolute confidence in the stability of a species, especially when it is based upon a single example.

SCOLOPENDRA DE HAANII, *Brandt*.

*Hab.* Mergui, Owen's Island.

## MYRIOPODA DIPLOPODA.

## Fam. POLYDESMIDÆ.

STRONGYLOSOMA SETOSUM, sp. n.

*Colour* (in alcohol) uniform testaceous throughout.

(Head and anterior 4 somites missing.) The keel-bearing portion of the rest of the somites thickly beset above and at the sides with long setæ, which project in all directions, and distinctly covered with squamiform granules. The transverse sulcus distinct. The keels small and slender, but distinct, situated in about the middle of the side, as long as the part of the tergite that bears them, their anterior angle nearly rectangular, the posterior acute and spiniform, the lateral edge armed with from 3 to 5 distinct sharp teeth. Anal tergite, sternite, and valves of normal form; the tergite stout, distally narrowed, truncate, the sternite posteriorly convex, the tubercles small. The sterna transversely and longitudinally grooved, not spined.

*Copulatory feet* long and slender, formed almost as in *Paradermus coarctatus*, the third segment long and cylindrical, and terminating distally with two slender curved processes which are closely applied together.

Length of specimen 19 millim. (when complete probably about 24 millim.).

*Hab.* Mergui. A single example from Owen's Island.

In spite of its damaged state, I have no hesitation in describing this specimen as the representative of a new species. It is entirely peculiar in its hairiness and in its dentate keels.

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The following new species of *Spirostreptus* are closely allied to *S. opinatus* and *S. aterrimus*, which Dr. Anderson obtained at Mergui.

They have the following features in common :—

*Head* smooth, with a superior crenulate ridge; frontal sulcus conspicuous, and extending to a point in a line with the inner angles of the eyes. *Eyes* separated by a distance that is greater than a diameter.

*Antennæ* with the second segment the longest. The *first tergite* smooth, extending laterally and inferiorly below the level of the second; the rest of the tergites marked with a complete

transverse sulcus, the anterior covered portion finely concentrically striolate, the posterior portion smooth, or nearly so, above, longitudinally striate below, the striæ not extending as high as the pore; pores situated in about the middle of the side, small just behind the transverse groove, which at this spot is lightly sinuate; *sterna* smooth; *ventral grooves* long and deep. *Anal tergite* produced into a caudal process, which overhangs the valves and is slightly upcurled at the apex (except in *S. Hosei*); *valves* convex, with compressed or sulcate margins; *sternite* triangular. *Legs* (in ♂) smooth above, the segments bearing a few hairs below, a spine above the claw and a few in two series on the lower surface of the terminal segment, which is not padded beneath; penultimate and antepenultimate padded beneath.

*SPIROSTREPTUS BOWRINGII*, sp. n.

♂. *Colour* (faded) mostly ochraceous, the hinder borders of the tergites castaneous; antennæ and legs concolorous, ochraceous. Distance between the eyes nearly twice a diameter.

*Antennæ* long, extending beyond the hinder margin of the first tergite.

*First tergite* moderately narrowed laterally, the anterior angle nearly a right angle, the margin thickened and defined by a strong sulcus, the posterior border lightly emarginate, the posterior angle also nearly a right angle, smooth or marked posteriorly with a few abbreviated sulci.

*Anal tergite* flat above from behind forwards, not transversely constricted, the caudal process slender, pointed, and upcurled; *valves* with their posterior border very lightly convex, margins strongly compressed, but hardly thickened; the *sternite* defined by a groove.

*Copulatory feet*—anterior lamina flat, slender, and diverging above, expanded and converging below, the inner edge of the terminal expansion emarginate and denticulate; the protrusible portion terminating in a lamelliform piece, and bearing two long, slender, subequal styles, which curve towards each other.

Number of segments 60.

Length 158 millim.

*Hab.* A single male example from Siam (*J. C. Bowring*).

Closely related to *Sp. opinatus*, Karsch, from Tenasserim and Mergui (*vide* Pocock, Journ. Linn. Soc., Zool. xxi. pp. 294, 295, pl. xxv. figs. 2-2c), but differing at least in the form of the

copulatory feet, the anterior lamina of which in *opinatus* is cut out so as to form two strong pointed styles.

*SPIROSTREPTUS PERAKENSIS*, sp. n.

♂. Colour black, polished; legs and antennæ reddish yellow.

Eyes separated by a space which is a little greater than a diameter. Antennæ long, projecting beyond the first tergite.

First tergite wide laterally, without striæ, the anterior angle rounded, very slightly obtuse, the margin thickened and defined by a strong sulcus, the posterior angle rectangular, the edge of the tergite above it very slightly emarginate. Rest of the tergites smooth and shining behind, the striæ falling considerably short of the pore.

Anal tergite with a light constriction, the process slender and short; valves strongly convex, margins strongly but narrowly compressed; sternite without a defining sulcus.

Copulatory foot with anterior lamina narrow above, expanded below, the inferior edge emarginate and bearing a median

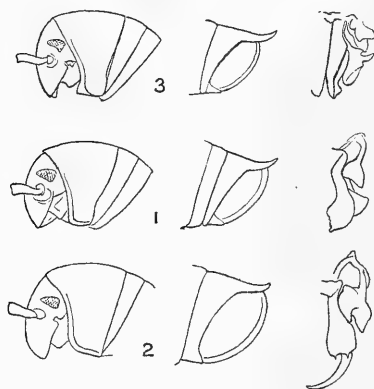


Fig. 1. *Spirostreptus Bowringii*, sp. n. Anterior and posterior extremities of body and front view of left half of copulatory organ.

Fig. 2. *Spirostreptus perakensis*, sp. n. Ditto.

Fig. 3. *Spirostreptus Patricii*, sp. n. Ditto.

spinule; the proximal spur of the protrusible portion very long and strong, the spurs on the base of the lamelliform portion short and more slender.

Number of somites 69.

Length about 210 millim.

*Hab.* A single male example from Perak (Malay Peninsula). Presented to the British Museum by J. H. Leech, Esq.

Very closely allied to *Sp. aterrimus*, Pocock, from Mergui, but having the legs and antennæ reddish yellow and concolorous, instead of fusco-annulate. Moreover, in *aterrimus* the inferior border of the anterior lamina of the copulatory foot is entire and not denticulate, and the large spur of the protrusible portion is hooked at the apex.

*SPIROSTREPTUS PATRICII*, sp. n.

♂. *Colour*—head castaneous below, olivaceo-fuscous above; antennæ olivaceo-fuscous, pale at the base; somites castaneous posteriorly; legs olivaceo-fuscous, testaceo-annulate.

*Eyes* separated by a distance about equal to a diameter and a half. *Antennæ* extending beyond the first tergite.

*First tergite* laterally slender, with its anterior angle slightly produced and much thickened, the posterior angle nearly a right angle, the anterior and posterior borders very lightly emarginate. Rest of the tergites very smooth posteriorly, the suture deep but not conspicuously crenulate, the lateral striæ extending nearly as high as the pore.

*Anal tergite* not constricted, the caudal process very long, slender, and upcurled; *valves* with their margins convex and not deeply compressed; the *sternite* defined by a groove. The coxal segment of the posterior pair of legs of the somites at the hinder end of the body bearing each a small tubercle.

*Copulatory feet*—anterior lamina slender, narrowed below, and externally hollowed, the protrusible portion terminating in a simple, apically spined lamelliform piece which does not support styliform spurs.

Number of somites 54.

Length about 120 millim.

*Hab.* A single male example from Batavia (*R. Kirkpatrick*).

Allied to *S. javanica*, Br., as shown by the form of the copulatory organ, but differing in the details of this apparatus, in having the anterior angle of the first tergite more produced, the legs and antennæ of a different colour, &c.

*SPIROSTREPTUS HOSEI*, sp. n.

*Colour* black or reddish black, the labial region, tip of caudal process, and margins of valves ferruginous; antennæ and legs fulvous, concolorous.

*Eyes* separated by a distance that is a little greater than a diameter. *Antennæ* shorter, only projecting beyond the first tergite by the terminal segment.

*First tergite* narrowed laterally, without grooves or ridges, the posterior border strongly emarginate, and the posterior angle acute; the anterior angle rounded and very obtuse, the margin thickened and defined above by a sulcus, which inferiorly disappears and expands into a depressed area. Rest of the tergites very lightly longitudinally rugulose behind, the striæ anteriorly extending nearly as high as the pore, but posteriorly reaching only halfway up. *Anal tergite* slightly constricted above, the caudal process robust, blunt, and not upcurled at the apex; the *valves* projecting posteriorly in their upper half, and widely compressed but not sulcate above, not compressed below; *sternite* not defined by a sulcus.

*Copulatory feet* with anterior lamina narrow above, expanded and spatulate below; the spurs on the protrusible portion rising on the same level at a point distal to the point of origin of the membranous lamelliform piece, one of them about twice the length of the other, and more slender and curved.

Number of somites 69.

Length nearly 200 millim.

*Hab.* A single male example from Baram, N.W. Borneo (*C. Hose*).

This species differs from all the preceding in having the anterior angle of the first tergite very obtuse, and the posterior acute and slightly produced; and in that the caudal process is stouter, blunt, not upcurled, and the margins of the valves are not compressed below.

*SPIROSTEPTUS EVERETTII*, sp. n.

*Colour* almost as in the preceding, but with the legs and antennæ brighter, and the whole anal somite black.

*Eyes* separated by a distance a little greater than a diameter. *Antennæ* short, overlapping the first tergite by their apical segment.

*First tergite* laterally narrowed, the anterior and the posterior border lightly emarginate, the anterior angle rounded and very obtuse, the posterior angle blunt, but smaller than a right angle. The rest of the tergites smooth above, the striæ even at the hinder end extending almost up to the pores.



*Anal tergite* lightly constricted; caudal process punctulate, moderately robust, the apex slightly upturned; the *valves* large and prominent, their margins evenly convex and strongly sulcate from top to bottom; the *sternite* defined by a groove.

*Copulatory feet* with the anterior lamina narrowed above, dilated and internally notched below, with its inner angle adorned with an inwardly directed spur; the protrusible portion armed with a single stout spur at the base of the terminal membranous expansion.

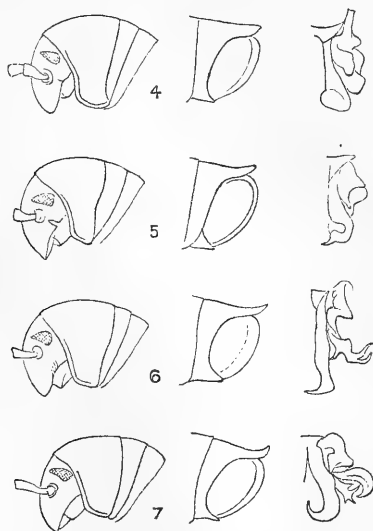


Fig. 4. *Spirostreptus Hosei*, sp. n. Anterior and posterior ends of body, and front view of left half of copulatory organ.

Fig. 5. *Spirostreptus Everettii*, sp. n. Ditto.

Fig. 6. *Spirostreptus baluensis*, sp. n. Ditto.

Fig. 7. *Spirostreptus dulititanus*, sp. n. Ditto.

Number of somites 65.

Length about 150 millim.

*Hab.* A single male example from N.W. Borneo (*R. Everett*).

Somewhat resembling the preceding (*S. Hosei*) in the shape of the first tergite, but differing in the form of the copulatory feet, of the anal valves, &c.

*SPIROSTREPTUS DULITITANUS*, sp. n.

♂. *Colour* black, caudal process and anal valves ferruginous, the latter mesially infusate; antennæ and legs flavous.

Body long and slender.

Distance between the eyes greater than a diameter.

*Antennæ* extending beyond the first tergite.

*First tergite* laterally but little narrowed, without striæ, the anterior angle obtusely rounded, the posterior rectangular.

*Tergites* smooth and polished, the posterior portion elevated, the striæ never extending so high as the pore.

*Anal somite*: caudal process apically upcurled, projecting considerably beyond the valves, the margins of which are thick; *sternite* not defined by a sulcus.

Legs moderately long.

*Copulatory feet* with the anterior lamina presenting the form of a strong inwardly directed hook; the protrusible part terminating in two processes, one of which is laminate and curled, the other shorter, bears a strong tooth near its point of origin, and is armed apically with four smaller teeth.

Number of somites 68.

Length 170 millim., width 10 millim.

*Hab.* A single male example from Mount Dulit, N.W. Borneo (*C. Hose*).

*SPIROSTREPTUS BALUENSIS*, sp. n.

♂. So closely allied to the preceding that a detailed description is unnecessary.

*Colour* as in *S. dulitianus*. Body more robust. The lateral extension of the first tergite thinner, the posterior border lightly emarginate above the posterior angle, the anterior angle a little more obtuse. The posterior half of the tergites scarcely elevated. The copulatory foot with its anterior lamina thinner than in *S. dulitianus*, the extremity being much less strongly curved; the protrusible portion terminating in a curled laminiform sclerite, and bearing four sharp spurs, three (two very long) at the base of the lamina, and another halfway along the cylindrical basal portion.

Number of somites 67. Width 12.2 millim.

*Hab.* A single male example from Mount Kina Balu, N.W. Borneo (*J. Whitehead*).

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On the *Buprestidæ* of Japan.

By G. LEWIS, F.L.S.

[Read 17th November, 1892.]

THIS paper is supplementary to a memoir on the Buprestidæ of Japan in the Journal of this Society, vol. xi. 1873, pp. 509–553, by Mr. Edward Saunders. In the earlier paper 36 species are recorded, and 20 are now added, and for the convenience of reference the names of all the species are brought together in a systematic list. I have struck out of the former catalogue *Buprestis Lecontei*, Saund., and *Ptosima chinensis*, Mars., having reasonable doubts as to their being Japanese; I have also rejected *Chrysochroa ocellata*, F., 1774, as I think Voet when he described it as *C. japonensis* in 1806 was in error in attributing the species to Japan. These species reduce the list slightly; but, on the other hand, there are 8 species of *Agrilus* left over, as they are only represented by specimens unfit for types.

Beyond the advantage of having Mr. Saunders' paper to guide me, I have been able to compare a considerable number of specimens with examples in the British Museum; the collection there, since the acquisition of the Saunders collection and the material more recently presented by Mr. Godman, is for the time being one of the best. I am also indebted to Mr. Waterhouse for kindly pointing out some of the characters he employed when writing on the Family for the 'Biologia.'

In the Trans. Amer. Ent. Soc. 1891, xiii. pp. 277–336, Dr. Horn has reviewed the N. American species of *Agrilus*, and refers at some length to their external sexual characters. In the Japanese series I have found several masculine characters which do not appear in the New World species; and this is quite in accordance with a familiar phase in the Coleoptera, viz., that subsidiary sexual differences are multiform, varying in different members of the same genus, and as such afford only specific characters. There is no evidence that the thoracic carina is a sexual character in the Japanese species, but it varies a little in individuals of either sex. In the American species, Dr. Horn thinks there are sexual differences in the carinæ, but under his notice of *Agrilus obtusus*, Horn, p. 288, there is a confusing printer's error, and in his description of *A. acutipennis*, Mann., he does not notice this character, although he refers to it in his preamble. In the latter species also he has "united the two forms" he

refers to, and these may be cognate species. In *A. otiosus*, Say, the male, however, is "distinctly carinate," the female "usually with a well defined carina." I think these are individual, not sexual differences.

CHRYSOCHROA ALTERNANS, *Waterh. Ann. & Mag. Nat. Hist.* 1888, i. p. 264.

*Hab.* Ruikiu Islands. Taken by Mr. Pryer in 1886. Type in the British Museum.

CHRYSOCHROA HOLSTII, *Waterh. Ann. & Mag. Nat. Hist.* 1890, v. p. 169.

*Hab.* Hachijo, an island near Yokohama. Two examples in the British Museum.

CHYSODEMA LEWISII, *Saund.*

*Hab.* Kiushiu and Ruikiu Islands. The original specimen came from Nagasaki, and in 1886 Mr. Pryer found it on Oshima.

DICERCA AINO, sp. n.

*Ænea* vel cuprea, rugosa, punctata; capite haud canaliculato; thorace tribus lineis lævibus; elytris valide furcatis; subtus aureo-cuprea. L. 18-20 millim.

*Æneous* or cupreous bronze. The head longitudinally rugose, not canaliculate; the thorax widest in the middle, hind angles little acute, sinuous at the base, very rugose, with two longitudinal smooth elevations in the centre having a few punctures, and two lateral elevations much broken by the intervening rugosities; the scutellum rather transverse, in one specimen longitudinally impressed; the elytra obsoletely striate, very rugose, interstices elevated, especially near the suture, broken by punctured spaces, and near the outer edge more generally interrupted by transverse rugosities, apices strongly furcate. Beneath, the coloration is brighter, golden and coppery; legs concolorous; the prosternum has the lateral margins raised, and the last ventral segment is canaliculate in the middle, apex with two incisions.

*D. amphibia*, Mars., from Siberia has the head "profoundly canaliculate" in the middle. *D. aino* is very similar to it and to *D. furcata*, Thunb.

*Hab.* Yezo. Two examples from the Ishikari River.

DICERCA TIBIALIS, sp. n.

Subconvexa, capite rugoso, cupreo, inter oculos leviter impresso; thorace in medio duabus lineis lævibus; elytris obscuro-æneis prave

costatis, interstitiis rugosissimis, apicalibus emarginatis; tibiis intermediis fortiter spinosis, tarsis cyaneis. L. 12 millim.

Head coppery, rugose, impressed between the eyes, with scattered whitish hair; the thorax with two broad median smooth lines or longitudinal spaces and a much shorter and broken smooth space outside of them; the thorax and elytra agree in colour with those of *Chalcophora japonica*, Gory, but the elytra have small scattered patches of whitish hairs. The elytral costæ very crooked and irregular, the interstices very rough and perforated rather than punctured; the apex of each is emarginate, the sutural and outer edge being prolonged into a denticulation. The legs coppery, tarsi cyaneous, middle tibiæ with a long spine on the inner edge projecting at right angles from just above the middle, between the spine and the tarsi the edge of the tibia is serrate.

This insect seems allied to the American species of the genus. It is similar to *D. asperata*, Lap., and *D. spreta*, Gory, as regards the apices of the elytra, and is somewhat like *D. tenebrosa*, Kirby, with respect to the tibial spine. Whether this spine is a sexual character I am unable to say.

*Hab.* Main island, on the 22nd June, 1881. A single example from a faggot of *Cryptomeria*-wood at Kashiwagi.

*PÆCILONOTA BELLULA*, sp. n.

Viridissima, lateribus auratis; elytris interstitiis nigro-vel cupreo-maculatis; antennis nigris, pedibus viridibus. L. 9-11 millim.

Bright green, with the sides of the thorax and elytra golden. The head rugosely punctate, face golden, antennæ black; the thorax widest in the middle, hind angles obtuse, bisinuous at base, a median line black, with indications of two others on each side, rugose at the sides, densely punctate on the disk; the scutellum transverse, hind angles slightly produced; the elytra punctate-striate, interstices rugosely punctured, with numerous patches or spots which are black in one light and coppery in another; apices trispinose. Beneath, more or less golden green; legs green.

This species may be placed next to *P. rutilans*, F.

*Hab.* Yezo. A small series taken at Junsai in August 1880.

*PÆCILONOTA VIVATA*, sp. n.

Viridis, subtus cyaneo-viridis; elytris 8-maculatis, maculis nigris; pedibus cyaneis. L.  $7\frac{1}{2}$ -9 millim.

Bright green above, bluish green beneath. The head densely little rugosely punctate, face impressed, antennæ nearly black; the thorax evenly and densely punctured, widest at the basal angle, base bisinuous, disk with a median black line behind the neck, with two black spots on each side of it before the base; the scutellum green, cordate; the elytra punctate-striate, interstices densely rugose; posterior margin of scutellum, two large spots over the hind coxæ, four transverse spots behind them and two others well before the apex black or purple-black; sometimes the apices are black and in these specimens there is also a black spot at the base of the elytra between the third and fourth striæ; the legs cyaneous.

This species is very similar to *P. festiva*, L., and *P. virgata*, Motsch.

*Hab.* Main island. Five examples from Kashiwagi on poles of *Cryptomeria japonica*.

*EURYTHYREA TENUISTRIATA*, sp. n.

Cyaneo-viridis. *E. micanti* proxime affinis; scutello impunctato; elytris in mediis tenui-striatis. L. 20-26 millim.

Bright bluish green, with thorax and sides of the elytra broadly golden. The head punctate, punctures rather large but not closely set, two shallow impressions between the eyes, and behind the impressions a well-marked median stria; the thorax, sides arched, feebly bisinuous behind the neck, punctures less dense than those on the head, an indistinct linear space in the middle sometimes smooth, scutellar fovea small but distinct and prolonged anteriorly as a stria; the scutellum conspicuously uneven and impunctate, semicircular behind; the elytra punctate-striate, the striæ nearest the suture being less impressed than the others, the interstices of the first being lightly punctulate, the latter slightly rugose transversely, the apices are emarginate, leaving the outer and sutural margins distinctly dentate. The under surface a bright green, with the margins of the segments and tip of the abdomen blue.

The elytral striæ are less deeply impressed than in *E. micans*, F.; the apices of the elytra agree best with those of *E. scutellaris*, Ol.; in the last the scutellum is smooth.

*Hab.* Main island. I have an example from Atami and another from Chichibu. There is a small specimen in the British Museum from Nikko.

*MELANOPHILA OBSCURATA*, sp. n.

Obscuro-ænea, dense punctata; thorace ante scutellum distincte foveolato; antennis pedibusque concoloribus. L. 11-12 millim.

Obscurely æneous, antennæ and legs concolorous, claws reddish. The head and thorax densely punctured, the latter rounded off before the anterior angle, obtuse at the hind angles, impressed with a very distinct fovea before the scutellum; the elytra rather more densely sculptured, apices obtusely and obscurely spinose and very feebly denticulate.

This insect resembles the European species *M. acuminata*, De Geer, and *M. atropurpurea*, Say, very closely, but the punctuation of the anterior angles of the thorax is clearer and the hind angles more rectangular. The species described from Mongolia is marked with yellow blotches. The species of this genus are very difficult to differentiate, but I believe this one is distinct from all the others described.

*Hab.* Yezo and Kiushiu. I caught one at Otaru and I have a second from Higo.

*CORÆBUS RUSTICANUS*, sp. n.

*C. rubi* simillimus, sed thorace elytris multo latoribus. Æneus, elytris albo-fasciatis. L.  $7\frac{1}{2}$  millim.

Æneous, with elytral fasciæ exactly corresponding to those of *C. rubi*, L. The head somewhat golden, canaliculate between the eyes, punctured, with vermicular sculpture; the thorax punctured behind the neck, sides with a crenulate strigosity, sides arcuate, little dilated, lateral edges rugose or subcrenulate; the scutellum wholly rugose; the elytra narrowly of a greenish hue along the suture; the dorsal sculpture is not so deep as in *C. rubi*; apices rounded off and obscurely denticulate. Legs bluish-black.

*Hab.* Yezo. One example at Junsai.

*CORÆBUS QUADRIUNDULATUS*, *Motsch.*

This species is very abundant and feeds on the common Japanese *Rubus*.

*Hab.* All the islands.

*AGRILUS CYANEONIGER*, *Saund.*

This species has no thoracic carina, and the superior part of the scutellum is triangular and ample. The marginal carina

of the connate segments of the abdomen is interrupted at a point which clearly indicates an obsolete suture. The suture can also be traced across the abdomen by a smooth line; the pygidium is carinate. The claws are robust and the inner process stout. There is a permanent variety in the northern parts of Japan which I name *A. cupreo-viridis*. The head and thorax are bright and coppery, and the elytra green.

The males have the inner edge of all the thighs densely pubescent.

*Hab.* All the islands, on the *Quercus serrata*, Thunb.

*AGRILUS SPINIPENNIS*, sp. n.

Capite vertice aureo, fronte viridi; thorace carinis brevibus, curvatis; elytris nigris, apicibus conspicue spinosis. L. 9-10½ millim.

The head golden, strigose on the summit, face rugosely punctured and bright green, with a median linear impression; the thorax golden or coppery, transversely rugose, especially on the disk, slightly constricted before the base, hind angles rather acute, carina short and curved; the scutellum bipartite, anterior portion transverse and angulate behind, inferior portion T-shaped, posteriorly very acute; the elytra black and very evenly and finely sculptured, having an appearance of opacity, apices denticulate, with the median portion of each elytron elongated and forming a conspicuous spine. The under surface and legs green with a fine greyish pubescence, abdominal suture clearly indicated; claws rather robust, inner process long. When not abraded there is a whitish pilosity on the elytra at the suture behind the middle. In the male the fore and intermediate tibiae are bent, the latter being spinose and swollen close to the tarsi.

Similar to *A. indigaceus*, Dey., from Dorey, and like others from Singapore and the Philippine Islands.

*Hab.* Main island. Seen in abundance 24th May, 1880, between Yokohama and Oyama, on a felled *Zelkova keaki*, Sieb.

*AGRILUS IMITANS*, sp. n.

*A. spinipenni* similimus, sed elytris haud spinosis. L. 9-10 millim.

The head aeneous, strigose on the vertex; face green, without a linear impression; the thorax golden and coppery, transversely rugose, carina short and curved; the scutellum bipartite, not angulate behind, inferior portion rugose and less acutely angulate than in *A. spinipennis*. The elytra black, finely and evenly



sculptured, apices simple and denticulate. ♂. Tibiæ as in the last species.

*Hab.* Main island. Five examples at Kashiwagi.

*AGRILUS ALAZON*, sp. n.

Capite thoraceque aureo-viridibus; elytris cyaneis vel cyaneo-viridibus, octo-albo-maculatis. L. 11–13½ millim.

The head and thorax golden green; head longitudinally strigose on the summit, transversely rugose on the face, with two lobe-shaped impressions; the thorax more coarsely rugose than the face and the rugosity more distinctly transverse, carina very short and curved, sides feebly emarginate before the posterior angles; the scutellum, anterior part transverse and rounded off on either side, inferior part triangular, each angle acute: the elytra cyaneous and sometimes greenish, the sculpture is not so fine and close as in *A. cyaneoniger*, Saund., especially near the suture in the dorsal area; there are four white spots on each elytron formed by a white and dense pilosity—first spot in the basal depression, second over the hind coxæ, third at an equal distance behind, fourth just before the apex and almost touching the suture; apex clearly denticulate and somewhat acutely produced. Beneath, the colour is wholly coppery; the marginal carina of the abdominal segment slightly deviates from a straight course at the supposed suture; the claws obtusely bifid.

Belongs apparently to the same group as *A. biguttatus*, F.

*Hab.* Kiushiu. I have a long series of this species from Yuyama in Higo.

*AGRILUS FORTUNATUS*, sp. n.

Cupreus vel viridi-æneus; thorace carinis brevissimis; elytris 6-albo-maculatis subtus æneus. L. 8–9 millim.

The head, summit golden, male with acicular punctures, female somewhat strigose, face green with a white pubescence, punctured and transversely rugose; the antennæ long, with lax joints; the thorax transversely rugose, hind angles a little prominent, carina very short, curved; the elytra evenly sculptured, with three spots of white or yellow pubescence, generally white, on each elytron—first within the basal impression, next just behind the posterior coxæ, third midway between the second and the apex, the apices are rounded off obtusely. The under surface and legs æneous, abdominal suture ill-defined; the tibiæ and tarsi slender, claws with inner process short. The outer edge of the hind

tibiæ are setose in both sexes. The male has the anterior and intermediate tibiæ enlarged and obtusely produced at the tarsal end like that figured by Horn, *l. c.* pl. 8. fig. 18, for the hind tarsus of *A. otiosus*.

*Hab.* Main island. Kiga, Nikko, and Chiuzenji in June.

*AGRILUS SOSPES*, sp. n.

Cupreus, thorace carinis obsoletis; elytris 6-maculatis; subtus, antennis pedibusque concoloribus. L. 8 millim.

Æneous, with the whole body, legs, and antennæ concolorous; the antennæ rather stout, with joints closely set; the head summit closely strigose; face rugose, with two lobe-shaped impressions; the thorax transverse, rather coarsely rugose, with a linear median impression and another, rather wider, within the middle of the lateral margin; the scutellum bipartite, anterior part finely strigose, rounded off laterally, inferior part rugose; the elytra somewhat unevenly sculptured, maculate like *A. fortunatus*, apices denticulate, rounded off on the outer edge. Beneath, the abdominal suture is indicated by two short sulci. Legs rather stout.

*A. sospes* is very similar to *A. fortunatus*, but it is much more robust, the vertex of the head clearly strigose and the antennæ shorter and compact.

*Hab.* Kiushiu. Four examples from Yuyama in Higo, 13th May, 1881.

*AGRILUS TEMPESTIVUS*, sp. n.

Æneus, capite vertice haud dense punctato, in medio distincte impresso; thorace postice 4-angulato. L.  $6\frac{1}{2}$  millim.

Brassy green, under surface and legs concolorous. The head summit not thickly punctured, strigosity more apparent in male than female; face rugosely punctured, with white pilosity, frontal edge of the vertex feebly channelled; the antennæ rather long, joints lax; the thorax transversely rugose, rather uneven, distinctly angulate at the base, carina curved; the scutellum, anterior portion with fine tessellate sculpture, inferior rugose, triangular and somewhat sharply produced behind; the elytra evenly sculptured, a little pilose towards the extremities, apex slightly prolonged and feebly denticulate. The abdominal suture is shown by two shallow transverse sulci.

Male with intermediate tibiæ nearly straight, but very distinctly spinose at the tarsal end.

The species is relatively longer and more parallel than the others of this list.

*Hab.* Main island. Usui-toge, Fukui, and Chiuzenji.

*AGRILUS TIBIALIS*, sp. n.

Obscure æneus; capite vertice leviter canaliculato; thorace lateribus impresso; ♂ tibiis posticis extus robustis. L.  $5\frac{1}{2}$ – $5\frac{3}{4}$  millim.

Obscurely æneous. The head, vertex strigose, face roughly punctured, with a white pilosity, feebly canaliculate on the summit; the antennæ, joints rather lax; the thorax somewhat quadrate, posterior angles slightly constricted, transversely rugose, impressed obliquely at the sides, carina short and ill-defined; the scutellum, superior part densely but finely sculptured. ♂, the thighs are very robust, tarsi short, hind tibia swollen on the outer edge before the apex; ♀, thighs much less stout, tibiæ simple.

The male characters of this species differ from all in this series.

*Hab.* Yezo. Taken commonly at Junsai and Sapporo.

*AGRILUS GRACILIPES*, sp. n.

Nigro-cyaneus. *A. tibiali* simillimus, sed pedibus gracilioribus. L.  $5\frac{1}{2}$ – $5\frac{3}{4}$  millim.

Blackish blue. The head, summit strigose, face roughly punctured, pilose, feebly canaliculate above; the antennæ rather long, joints lax; the thorax transversely strigose, carina short and curved, not well defined, posterior angles a little acute, impressed at the sides; the elytra evenly sculptured, apices obscurely denticulate; the legs and tarsi slender and rather elongate, in the male intermediate tibiæ feebly bent with the apex slightly enlarged.

There are only slight characters to distinguish this species from *A. tibialis*, except in the legs, which are very different. It is the only blue species from Japan with slender legs; in this respect it agrees with *A. fortunatus*.

*Hab.* Main island. Nikko, Nara, and Miyanoshita.

*AGRILUS DISCALIS*, *E. Saund.*

This species has a remarkable thoracic carina which extends from the base to the anterior angle and is widely sinuous in the middle of its course.

*Hab.* Kiushiu and Main island. Common in winter under the loosened bark of *Zelkova keaki*, Sieb. Taken abundantly at Bukeuji near Yokohama in March.

*AGRILUS CUPES*, sp. n.

Viridi-cyaneus, nitidus; thorace ante scutellum depresso, lateribus parum dilatato, postice obtuse angulato; elytris vix dense asperatis. L.  $5\frac{1}{2}$ –6 millim.

Bright bluish green, rather robust. Antennæ rather stout and joints compact; the head strigose above and rugose between the lines, channelled in the middle, face rugosely punctate; the thorax transversely rugose, little dilated laterally, hind angles obtuse, base sinuous, before the scutellum a somewhat deep depression circular in outline, carina short and bent; the scutellum is strigosely sculptured, with a transverse ridge in the middle, but not conspicuously bipartite as in the preceding species, *A. spinipennis*, and the three following; the elytra, sculpture not very dense, apices obtuse and obscurely denticulate. Beneath, the abdominal suture is scarcely indicated; in one specimen the colour is blue, in the other green. The first joint of the hind tarsus is short.

This is the brightest coloured species in the series.

*Hab.* Main island. Numata and Chiuzenji, two examples.

*AGRILUS BREVITARSIS*, sp. n.

Cupreus, robustus, immaculatus; antennis tarsisque brevibus, subtus pedibusque æneis. L. 8 millim.

Cupreous; the head rugose, very similarly sculptured on the vertex and face, but the sculpture on the former is arranged longitudinally, median impression conspicuous on the anterior edge of the vertex; the antennæ short and robust, joints not lax; the thorax transversely and somewhat coarsely rugose, impressed twice in the middle and once on either side within the margin, hind angles obtuse; the scutellum bipartite, upper portion truncate at the sides and thickly punctulate, inferior portion T-shaped, with the transverse piece rugose and the hinder part punctulate; the elytra immaculate, not very evenly sculptured, denticulate at the apex; the legs æneous, tarsi short, claw with inner process scarcely visible. The first joint of the hind tarsus is conspicuously shortened.

*Hab.* Main island. Found at Chiuzenji, 14th June, 1881.

Some of the American species of *Agrilus* have the fourth joint of the antennæ cylindrical; this is not the case in any species of this series.

*TRACHYS EXIMIA*, sp. n.

Aureo-cuprea, nitida; elytris dense griseo-pubescentibus in regione scutellari et apice exceptis; subtus ænea. L. 3 millim.

The outline of this pretty species agrees with *T. Lewisii*, Saund.; it belongs to a section in the genus with "the body depressed, thorax flattened out at the sides; elytra with a carina above the margin" (*l. c.* p. 519). The head is almost impunctate, forehead angularly impressed, with a median line in the impression; the thorax with large shallow, sometimes confluent, punctures at the sides, finely rugose on disk, pilose, base trisinuous; the elytra very densely and conspicuously clothed with greyish pilosity, except a triangular space round the scutellum and a smaller region at the apex. The spaces are finely rugose and of a golden-coppery colour. The legs and underside are æneous.

*Hab.* Kiushiu. Ten examples taken in the Higo forests.

*TRACHYS SAUNDERSI*, sp. n.

Suboblonga, capite thoraceque aureo-pilosis; elytris nigris, fasciis conspicue flexuosis, griseo-sericeis ornatis. L. 3-4 millim.

This species in outline and size agrees with *T. subbicornis*, Mots., but the coloration is like that of *T. auricollis*, Saund. *T. auricollis*, Saund., is very broad-shouldered, which gives it a triangular outline, and it occurs chiefly in S. Japan.

*Hab.* Main island. Sixteen examples taken at various places on the Nakasendo.

*BRACHYS SALICIS*, sp. n.

Parum convexa; capite thoraceque æneis, nitidis, vix punctatis; fronte valide excavata utrinque bifoveolata; elytris nigro-cyaneis, fasciis griseis ornatis. L. 3 millim.

The head and thorax brightly æneous, the latter a little punctate on the sides; the forehead is deeply excavated, with two small but very distinct foveæ behind the antennæ; the elytra are blackish blue, little rugose and sparsely punctate, with four griseous fasciæ, the basal fascia is sometimes obliterated, the third most flexuous, the fourth nearly straight.

This is the only species of this genus known from the Oriental region.

*Hab.* Main island. On sallow at Subashiri, Miyanoshta, and Kioto.

*Systematic List of Species.*

- Chrysochroa fulgidissima*, *Schoenh.*  
*elegans*, *Thunb.*  
*fulgida*, *Oliv.*  
*cæruleocephala*, *Motsch.*  
— *alternans*, *Waterh.*  
— *Holstii*, *Waterh.*  
*Chalcophora japonica*, *Gory.*  
— *querceti*, *Saund.*  
*Chrysodema Lewisii*, *Saund.*  
*Dicerca aino*.  
— *tibialis*.  
*Pœcilonota bellula*.  
— *vivata*.  
*Buprestis japonensis*, *Saund.*  
*Eurythyrea tenuistriata*.  
*Melanophila obscurata*.  
*Anthaxia proteus*, *Saund.*  
*Chrysobothris succedanea*, *Saund.*  
*Coræbus rusticanus*.  
— *ignotus*, *Saund.*  
— *quadriundulatus*, *Motsch.*  
*Sambus quadricolor*, *Saund.*  
*Cryptodactylus auriceps*, *Saund.*  
*Agrilus cyaneoniger*, *Saund.*  
    *Var. cupreoviridis.*  
— *spinipennis*.  
— *imitans*.  
— *alazon*.  
— *fortunatus*.  
— *sospes*.  
— *tempestivus*.  
— *trinotatus*, *Saund.*  
— *auriventris*, *Saund.*  
*Agrilus tibialis*.  
— *gracilipes*.  
— *discahis*, *Saund.*  
— *rotundicollis*, *Saund.*  
— *cupes*.  
— *mœrens*, *Saund.*  
— *maculifer*, *Saund.*  
— *brevitarsis*.  
— *subrobustus*, *Saund.*  
— *viridiobscurus*, *Saund.*  
— *pilosovittatus*, *Saund.*  
— *marginicollis*, *Saund.*  
— 8 *uniques*.  
*Cylindromorphus japonensis*, *Saund.*  
*Aphanisticus collaris*, *Saund.*  
— *antennatus*, *Saund.*  
— *congener*, *Saund.*  
*Trachys Lewisii*, *Saund.*  
— *eximia*.  
— *griseonigra*, *Saund.*  
— *elegantula*, *Saund.*  
— *auricollis*, *Saund.*  
— *Saundersi*.  
— *sub-bicornis*, *Motsch.*  
    *griseofasciata*, *Saund.*  
— *robusta*, *Saund.*  
— *inconspicua*, *Saund.*  
— *cupricolor*, *Saund.*  
— *variolaris*, *Saund.*  
— *inedita*, *Saund.*  
*Brachys salicis*.  
*Paratrachys hederæ*, *Saund.*
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On a small Collection of Crinoids from the Sahul Bank, North Australia. By Prof. F. JEFFREY BELL, M.A., Sec. R.M.S. (Communicated by W. PERCY SLADEN, Sec. Linn. Soc.)

[Read 1st December, 1892.]

(PLATES XXIII. & XXIV.)

SOME years since Dr. John Anderson, F.R.S., entrusted to the late Dr. Herbert Carpenter a small collection of Crinoids from the Sahul Bank, of which he had become possessed as Superintendent of the Indian Museum, Calcutta. To this collection my lamented friend was never able to give much attention, and he does not appear to have left any notes of his observations on the specimens contained in it. Mr. Wood-Mason, the present Superintendent of the Indian Museum, has allowed me to examine the collection, which I find to present a few points of interest.

Only one species of Stalked Crinoid is represented and none of the individuals are in a very satisfactory condition. There can, however, be no doubt that the species is the *Metacrinus interruptus* of P. H. Carpenter, described on pp. 367-9 of his 'Challenger' Report; the single specimen on which the species was founded was taken in  $10^{\circ} 14' N.$ ,  $123^{\circ} 54' E.$ , at a depth of 95 fathoms. The specimens in the present collection were taken from a telegraph-wire in  $11^{\circ} 30' S.$ ,  $125^{\circ} E.$ , or about as many degrees south as the other was north of the line; the depth, unfortunately, is not given.

#### ANTEDON LONGICIRRA.

*Antedon longicirra*, P. Herbert Carpenter, *Report on the Comatulæ*, Zool. Chall. Exp. vol. xxvi. (1888), p. 103.

Dr. Carpenter founded this species on a single specimen, and was therefore unacquainted with the very considerable range of variation in the length of the cirri in different specimens of this species. While one specimen may have cirri 80 or more millim. long, as in the type, in others the cirri may not be more than 60 millim. long. In this point, therefore, the cirri may be more like those of *A. incerta* than of *A. longicirra*. The present specimens are shown, by the simple condition of the second pinnule and the comparative shortness of the joints of the cirri, to belong to *A. longicirra*. When I first noticed the variation in the length of the cirri, I thought it might be possible to show that the two

species (*A. incerta* and *A. longicirra*) should be united. The other distinctive characters, however, on which Carpenter insists seem, so far as *A. longicirra* is concerned, to be constant, and with the present condition of our collections the species can still be readily distinguished.

ANTEDON WOOD-MASONI, sp. n. (Pl. XXIII. & Pl. XXIV., fig. 1.)

This new species belongs to Carpenter's *Spinifera*-group; that is, it is bi-distichate and has some of the basal joints more or less wall-sided. As it has more than thirty cirrus-joints, the more distal of which are spiny, the first pinnule as long as or longer than the second, and the cirri not arranged in rows on the centrodorsal, it stands nearest to *A. duplex* (P. H. C. MSS.) and *A. lusitanica*. The former of these has from 30-40 cirrus-joints, the latter 50; the present would appear to have from 35 to 45; the radial axillaries are short and wide as in *A. lusitanica*, and there is no noticeable expansion of any of the joints of the pinnules.

The following may serve as a specific diagnosis:—

A member of the *Spinifera*-group, and falling under the same subdivision as *A. duplex* and *A. lusitanica*. Centrodorsal rather large, but not columnar, the central portion free of cirrus-sockets; about 18 cirri, with 35-45 joints; these begin to be spiny at about the tenth joint, and the spine, though not large, is quite well marked. First radials hidden, the second much wider than long, slightly concave on its distal side; the axillary wide, with two slight concavities for the reception of the first distichal, which again is much wider than long; the distichal axillary of much the same shape as the radial; the two visible radials and the distichals have a median linear tubercle.

20 arms. Basal joints with fairly regular sides; the third a syzygy; then one, ordinarily, on the 12th or 14th joint; then not another for 12 or 14 joints. The arm-joints gradually become triangular, flattened from side to side, and provided with a median ridge. The pinnules are styliform, but short and with simple joints; they increase somewhat in length nearer the end of the arm.

Diameter of disk 6 millim. Length of arms 110 millim.

Colour white, with faint patches of brown here and there.

*Hab.* Sahul Bank, North Australia.

In Coll. B.M. and Ind. Mus., Calcutta.



ANTEDON PATULA. (Pl. XXIV. figs. 2-6.)

*Antedon patula*, P. Herbert Carpenter, *Report on the Comatulæ*, Zool. Chall. Exp. vol. xxvi. (1888), p. 219.

I was at first inclined to consider the four specimens which I include under this name as representatives of a new species. Carpenter's species is, however, founded on two specimens of much the same size, and smaller and younger examples such as I have had before me might well have a smaller number of cirri and a less marked development of the ridge on the more distal of the arm-joints. *Antedon flexilis*, *A. patula*, and *A. robusta* were all taken at the same station by the 'Challenger'; and it is very likely that an increase in our series may show that there are not so many well-marked species as has been supposed.

EXPLANATION OF THE PLATES.

PLATE XXIII.

Fig. 1. *Antedon Wood-Masoni*, to show the general aspect of the form.  $\times \frac{2}{3}$ .

Fig. 2. A cirrus.  $\times 3$ .

Fig. 3. A younger cirrus.  $\times 3$ .

PLATE XXIV.

Fig. 1. Disc and proximal portions of the arms of *A. Wood-Masoni*, to show the form of the joints.  $\times 3$ .

Figs. 2-4. The arms of three different specimens of *Antedon patula*, to show the variations in the appearance of the arm-joints.  $\times 3$ .

Figs. 5 & 6. Cirri of the same.  $\times 3$ .

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Descriptions of new Species of Land-Shells from Borneo. By  
EDGAR A. SMITH. (Communicated by W. PERCY SLADEN,  
Sec. Linn. Soc.)

[Read 1st December, 1892.]

(PLATE XXV.)

THE specimens about to be described form part of a collection from Borneo, forwarded to the British Museum in June of this year. The types of all the new species have been liberally presented to the Museum by Mr. A. Everett, by whom they were collected. A previous consignment also collected by Mr. Everett in that island has been carefully worked out by Lieut.-Col. H. H. Godwin-Austen in the Proceedings of the Zoological Society, 1889, pp. 332-355, and 1891, pp. 22-47. They were all obtained

from various localities in the north or north-eastern part of the island, several of which have not previously been explored for specimens of natural history.

I would direct special attention to the remarkable forms of *Opisthostoma* and *Diplommatina*. Of the former only two species from Borneo were known prior to the discovery of the remarkable *O. grandispinosum*\*, *O. pulchellum*, and *O. Hosei*, which were described by Godwin-Austen. I have now the pleasure of adding five additional species to the list, one of which at least (*O. mirabile*) is a worthy rival of *O. grandispinosum*, the most wonderful of the known ones, in the beauty of its structure.

Of *Diplommatina* ten Bornean species have already been described; six more are now added, of which *D. excentrica* and *D. Everetti* are very grotesque forms.

Of *Arinia*, a genus not hitherto known from Borneo, two species are here recorded.

Mr. Everett has promised further collections, and the new and interesting species they may contain I hope to describe in a future paper.

#### 1. NANINA (XESTA) MOLUENSIS. (Pl. XXV. fig. 1.)

Testa anguste perforata, orbicularis, superne breviter conica, tenuis, polita, subpellucida, virescenti-albida, zona angusta saturate brunnea supra suturam et supra medium anfractus ultimi cincta, circa peripheriam fascia lata dilutiore, alteræ juncta, ornata, incrementi lineis tenuissimis striisque spiralibus exilissimis utrinque sculpta; anfractus  $5\frac{1}{2}$ , regulariter crescentes, infra suturam anguste et impresse marginati, ultimus haud descendens; apertura parum obliqua, late lunata; peristoma tenue, margine columellari obliquo, leviter incrassato, albido, supra umbilicum breviter reflexo.

Alt. 16 millim., diam. maj.  $25\frac{1}{2}$ , min. 21. Apertura  $10\frac{2}{3}$  longa, 12 lata.

*Hab.* Molu or Mulu Mountains, N. Borneo.

This species appears to be distinct from the allied forms of *Xesta* and is distinguishable by its form and coloration.

#### 2. SITALA RARICOSTULATA. (Pl. XXV. fig. 2.)

Testa turbinata, conica, subrimata, pallide fuscescens; anfractus 7, lente crescentes, tres primi liris tenuibus 5-6 spiralibus cincti, cæteri costulis leviter obliquis subremotis haud æquidistantibus instructi, ultimus ad

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\* Unnecessarily placed in a new genus (*Geothauma*) by Crosse, Journ. de Conch. 1892, p. 282.

peripheriam carina filiformi cinctus, infra carinam lævis; apertura parva, angusta; peristoma tenue, margine columellari leviter incrassato et reflexo.

Alt.  $2\frac{1}{2}$  millim., diam.  $2\frac{3}{8}$ .

*Hab.* Busau or Busan, Sarawak.

This species is remarkable for the character of its sculpture. The spirally lirate apical whorls, the costulation of the rest, the keel encircling the body-whorl and its smooth base are the principal distinguishing features. The carina is visible above the suture upon the penultimate and preceding whorls.

### 3. *SITALA BARITENSIS*. (Pl. XXV. fig. 3.)

Testa trochoidea, pallide fuscens, vix rimata, spira regulariter conica; anfractus 6, convexiusculi, lente accrescentes, striis spiralibus tenuissimis, lineisque incrementi obliquis sculpti, ultimus in medio acute angulatus, carinatus, inferne convexiusculus, spiraliter et longitudinaliter striatus; apertura parva, ad carinam angulata; peristoma tenue, margine columellari leviter arcuato, incrassato et reflexo.

Alt.  $2\frac{3}{8}$  millim., diam.  $2\frac{3}{8}$ .

*Hab.* Barit Mountain.

The spiral striæ are about seven or eight in number upon the penultimate and upper volutions.

### 4. *SITALA MOLUENSIS*. (Pl. XXV. fig. 4.)

Testa turbinata, conica, subrimata, fusca; anfractus 6, regulariter crescentes, convexi, liris paucis tenuibus cincti, incrementique lineis obliquis sculpti, ultimus ad peripheriam acute rotundatus, et carina filiformi ornatus, infra carinam haud spiraliter liratus, convexiusculus; apertura parva, lunata; peristoma tenue, margine columellari oblique arcuato, superne leviter incrassato et reflexo.

Alt.  $2\frac{3}{4}$  millim., diam.  $2\frac{1}{2}$ .

*Hab.* Molu or Mulu Mountains, N. Borneo.

This species is of a darker colour than *S. baritensis*, has the whorls rather more convex, the last less acute at the middle, and much stronger spiral sculpture. Under the microscope, in addition to the liræ, very fine spiral striæ are more or less observable.

### 5. *CYCLOPHORUS EVERETTI*. (Pl. XXV. figs. 5, 5 a.)

Testa depressa, orbicularis, latissime et perspective umbilicata, saturate castanea, ad peripheriam zona angusta nigrescente superne pallide marginata cincta, lineis albidis irregularibus undulatis subzigzag-formibus ornata; anfractus 4- $4\frac{1}{2}$ , convexi, sutura profunda sejuncti, lineis incrementi tenuibus obliquis sculpti, ultimus antice descendens, infra pallidior; apertura sordide cærulescens, ovato-circularis, latior quam alta; peristoma

leviter incrassatum, sordide albidum, superne haud expansum, ad marginem columellarem subreflexum.

Diam. maj. 37 millim., min. 26; alt. 20. Apertura 18 lata, 15 alta.

*Hab.* Barit Mountain.

This is a smooth depressed species with convex whorls, a wide umbilicus, and the peristome scarcely expanded or reflexed excepting towards the umbilicus. The first two or three whorls have stronger and more distant lines of growth than the last and penultimate whorls, the change of sculpture being marked by a distinct line which apparently indicates the termination of the first season's growth. In young and very fresh specimens the fine incremental lines have the appearance of being minutely granular. The wavy or more or less zigzag whitish markings almost disappear upon the last third of the body-whorl. Beneath the blackish peripheral zone, the dark chestnut ground-colour extends about five or six millimetres, the rest of the base being of a paler tint.

#### 6. *LAGOCHEILUS BARITENSIS*. (Pl. XXV. fig. 6.)

Testa mediocriter umbilicata, turbinata, tenuis, albida ad apicem fusca, epidermide olivaceo-fusca induta, strigis pallide rufis a sutura radiantibus ornata; anfractus 6, convexiusculi, in medio et inferne ad suturam carinati, lineis incrementi tenuibus striati, ultimus ad peripheriam carinatus, inferne obsolete spiraliter striatus, carina vel lira circa umbilicum interdumque alia prope peripheriam instructus, antice vix descendens; apertura intus livida; peristoma duplex, tenue, late et plane expansum, haud reflexum, marginibus ad parietem fere interruptis.

Diam. maj.  $14\frac{1}{2}$  millim., min. 11; alt.  $13\frac{1}{2}$ . Apertura 6 alta et lata.

*Hab.* Foot of Barit Mountain, N.W. Borneo.

This species is remarkable for its pale ground-colour, which, with the exception of the spire, is mostly covered with a brownish-olive periostracum. The apex is brown, and the body-whorl exhibits numerous red markings which radiate from the suture. The most characteristic feature of this species is the broad flat expansion of the peristome, which is considerably, although not entirely, interrupted where it joins the whorl. The notch at the suture is very slight indeed. The keel or lira which encircles the periphery is a little thicker than the others.

#### 7. *LAGOCHEILUS JUCUNDUS*. (Pl. XXV. fig. 7.)

Testa late umbilicata, turbinata, castanea, lineis albis a sutura radiantibus et angulatis supra ornata; anfractus 5, convexi, sutura subprofunda discreti,

*liris tenuissimis paucis* (in anfr. superioribus 3, ultimo 4) spiraler cineti, lineis incrementi exilissimis striati, ultimus ad peripheriam acute rotundatus, inferne striis spiralibus parum distinctis sculptus, antice vix descendens; apertura intus albida, circularis; peristoma leviter incrassatum, duplex, superne vix expansum, inferne et prope umbilicum angustissime reflexum.

Diam. maj. 11 millim., min. 8; alt.  $8\frac{1}{2}$ . Apertura 5 longa et lata.

*Hab.* N.E. Borneo.

The white radiating markings which ornament the upper surface of this pretty species stop short at the periphery, leaving the base of a uniform chestnut tint. The notch in the peristome is slight, but quite evident at the point where the upper margin meets the whorl. Of the four thread-like liræ upon the body-whorl, the three uppermost revolve up the spire, and the fourth, which is just below the periphery, passes into the suture and is not seen upon the upper whorls.

#### 8. *LAGOCHEILUS INORNATUS*. (Pl. XXV. fig. 8.)

Testa depresso turbinata, mediocriter umbilicata, albida, pellucida, ad peripheriam carina filiforme cincta, striis incrementi tenuibus sculpta; spira breviter conica; anfractus 5-6, convexi, inferne prope suturam carina vel lira spirali instructi, ultimus circa umbilicum lira alia ornatus, ad carinam medianam epidermide pilosa amictus, antice vix descendens; apertura circularis; peristoma duplex, margine externo mediocriter expanso, subreflexo.

Diam. maj.  $8\frac{1}{2}$  millim., min. 7; alt. 7. Apertura  $3\frac{1}{3}$  longa et lata.

*Hab.* Gomanton, N. Borneo.

This species is peculiar in the absence of markings and on account of the peripheral and basal liræ.

#### 9. *LAGOCHEILUS ALTUS*. (Pl. XXV. fig. 9.)

Testa parva, elato-conica, anguste perforata, subpellucida, pallida, epidermide tenuissima pilosa induta, strigis obliquis rufescentibus ornata; anfractus  $5\frac{1}{2}$ , convexi, *liris* tenuibus pilosis (in anfr. superioribus 2, in ultimo 5) incrementique lineis obliquis tenuibus subdistantibus late cancellati, ultimus rotundatus, haud descendens; apertura circularis; peristoma intus leviter incrassatum, album, extra anguste expansum, rufescens, ad parietem tenuissimum.

Diam. maj. 4 millim., min. 3; alt.  $4\frac{1}{2}$ . Apertura 2 longa et lata.

*Hab.* Busau, N.W. Borneo.

The apical whorls are reddish, but this may be partly due to the remains of the animal. The spiral elevated lines are a trifle coarser than the rather distant oblique ones, and it is at the points of intersection that the short epidermal hairs arise.

10. *LAGOCHEILUS BORNEENSIS*. (Pl. XXV. figs. 10, 10 a.)

Testa parva, depressa, late umbilicata, pallida, strigis rufis obliquis radiantibus ornata, epidermide tenui pilosa induta; anfractus 5, convexi, striis spiralibus tenuibus incrementique lineis obliquis minute cancellati, ultimus subtus nitidior quam supra, antice subdescendens; apertura rotundata; peristoma vix incrassatum, margine externo anguste expanso, columellari angustiore.

Diam. maj.  $6\frac{1}{3}$  millim., min.  $5\frac{1}{2}$ ; alt.  $4\frac{1}{2}$ . Apertura  $2\frac{1}{2}$  alta et longa.

*Hab.* Barit Mountain, N.W. Borneo. The variety (fig. 10 a) is from Busau.

This is a pretty little striped species clothed with a finely pilose epidermis. The slight emargination or notch on the peristome is very minute. Two figures are given to show the variation in form.

11. *OPISTHOSTOMA MIRABILE*. (Pl. XXV. figs. 11, 11 a.)

Testa dextrorsa, conica, anguste et profunde umbilicata, rufescens vel pallida; anfractus 7, convexi, primi duo læves, cæteri lamellis tenuissimis pellucidis, remotis, spinis elongatis fere rectis sursum directis, instructis, ornati; spinarum series in anfr. ultimo valde curvata; lamella ultima pone aperturam maxima, scutiformis; apertura retrorsa, circularis; peristoma tenue, leviter expansum.

Alt. 4 millim., diam. maj. 5, min.  $2\frac{1}{2}$ . Apertura cum perist.  $1\frac{1}{2}$  lata.

*Hab.* Gomanton Hill, N. Borneo.

The long upcurved spines which form a single series around the whorls are almost straight upon the upper volutions, but upon the last, which is detached for some distance from the penultimate and is twisted backward and upward, they are much curved towards the umbilicus. They are pellucid and semitubular. The most striking feature of this wonderful species is the great development of the last lamella behind the aperture, where it forms a sort of ear-shaped shield.

12. *OPISTHOSTOMA EVERETTI*. (Pl. XXV. figs. 12, 12 a.)

Testa dextrorsa, conica, rimata, rufescens vel alba; anfractus 5- $5\frac{1}{2}$ , convexi, primi duo læves, cæteri lamellis obliquis tenuissimis in medio spiniformibus instructi, ultimus antice longe solutus, versus aperturam retrorsum et sursum contortus, seriebus duobus spinarum ornatus; spinæ semitubuliformes, curvatae; series inferior longior, cristam basalem formans; apertura circularis rufescens vel alba; peristoma tenue, undique late expansum et concentrice striatum.

Alt. 3 millim., diam. maj.  $3\frac{2}{3}$ , min. 2. Apertura cum perist.  $1\frac{1}{2}$  lata.

*Hab.* Jambusan, N.W. Borneo.

In this species the oblique lamellæ are rather far apart and

produced into semitubular short spines, forming a spiral series around the middle of the penultimate and one or two preceding volutions. The spines of the lower series on the body-whorl are longer than those above, curve backward, and form a crest around the base. The aperture, which is trumpet-shaped, is directed backwards.

13. *OPISTHOSTOMA JUCUNDUM*. (Pl. XXV. figs. 13, 13 a.)

Testa umbilicata, conica, plus minus rufescens; anfractus 7, apicales læves, rotundati, cæteri lamellis numerosis tenuibus obliquis in medio subproductis instructi, ultimus contortus, retrorsus, antice solutus; peristoma tenue, anguste reflexum.

Alt.  $2\frac{1}{2}$  millim., diam. maj. 3, min.  $1\frac{1}{2}$ . Apertura 1 lata.

*Hab.* Mantanani Island, N. Borneo.

This species is a little smaller than *O. Everetti*, consists of a whorl more, has more numerous lamellæ, which have a wavy appearance upon the body-whorl, and are a little produced about the middle of the upper volutions, so that they have a somewhat angular appearance.

14. *OPISTHOSTOMA WALLACEI*, *Ancey*. (Pl. XXV. figs. 14, 14 a.)

*Plectostoma Wallacei*, *Ancey*, *Bull. Soc. Mal. France*, 1887, p. 276=

*Opisthostoma cristatum*, *Smith*, *MSS.*

*Hab.* Busau, N.W. Borneo.

This species is a trifle less robust than *O. jucundum*, much more closely lamellated, has a more expanded peristome, and a distinct basal crest or ridge upon the body-whorl.

Specimens of this species have been distributed under the name of *O. cristatum*, *Smith*. Forgetting that *Plectostoma* was synonymous with *Opisthostoma* I overlooked the description of this species by M. Ancey under the name of *Plect. Wallacei*.

15. *OPISTHOSTOMA BARITENSE*. (Pl. XXV. figs. 15, 15 a.)

Testa elata, ovato-conica, rufescens, angustissime perforata; anfractus 6, perconvexi, sutura profunda sejuncti, primus lævis, cæteri oblique subconferte tenuissime lamellati, ultimus retrorsum et sursum contortus, breviter solutus; peristoma leviter expansum.

Alt.  $2\frac{1}{3}$  millim., diam. maj.  $2\frac{1}{3}$ , min.  $1\frac{1}{2}$ . Apertura  $\frac{2}{3}$  lata.

*Hab.* Barit Mountain, N.W. Borneo.

This species is about the same size as *O. Wallacei*, but is more pupiform, redder, more distantly lamellated; the body-whorl has no basal crest, and the aperture and peristome are smaller.

16. *OPISTHOSTOMA BUSAUENSE*. (Pl. XXV. figs. 16, 16 a.)

Testa minuta, anguste perforata, plus minus rufescens; anfractus 5, perconvexi, sutura profunda sejuncti, apicales 1-2 læves, sequentes oblique et distanter tenuiter lamellati, ultimus antice confertius lamellatus, vix solutus, retrorsum et sursum contortus, inferne subcristatus; apertura mediocriter magna; peristoma album, duplex, margine externo interno latius expanso.

Alt.  $1\frac{1}{2}$  millim., diam. maj.  $1\frac{1}{2}$ , min. 1. Apertura cum perist.  $\frac{2}{3}$  lata.

*Hab.* Busau, N.W. Borneo.

This is a very minute species, and considerably smaller than any of those previously described. The lamellæ are quite far apart, excepting upon the contorted portion of the body-whorl, where they become crowded.

17. *DIPLOMMATINA SULPHUREA*. (Pl. XXV. fig. 17.)

Testa ovata, superne acuminata, imperforata, sinistrorsa, flavescens; anfractus 8, convexi, lineis incrementi tenuibus obliquis sculpti, penultimus gibbosus, ultimo lator, ultimus contractus, primum valde obliquus, antice conspicue ascendens; apertura irregulariter rotundata, sulphurea, longit. totius  $\frac{1}{3}$  adæquans; peristoma tenue, leviter expansum, flavum, marginibus callo tenui junctis, columellari rectiusculo, intus denticulo mediano munito, supra regionem umbilici duplici, partim appresso, partim libero prominente.

Longit. 7 millim., diam. 3. Apertura  $2\frac{1}{2}$  longa.

*Hab.* Molu or Mulu Mountain.

The sulphur colour is rather more vivid within the aperture than upon the exterior of the shell. The lip is simple, merely slightly expanded and reflexed.

18. *DIPLOMMATINA MOLUENSIS*. (Pl. XXV. fig. 18.)

Testa acuminato-ovata, sinistrorsa, imperforata, cerea, subnitida, versus apicem rubra; anfractus 7, convexi, regulariter crescentes, costulis tenuibus obliquis leviterque flexuosis subdistantibus instructi, ultimus contractus, antice ascendens, penult. leviter gibbosus, latitudine ultimum æquans; apertura rotundata, ad columellam recta, inferne leviter canaliculata, intus flava; peristoma duplex, margine interno continuo, porrecto, externo lamelliformi, expanso; columella recta, dente parvo instructa.

Longit. 5 millim., diam  $2\frac{1}{2}$ . Apertura 2 longa.

*Hab.* Molu or Mulu Mountain, N. Borneo.

This species is of a glossy waxy yellow colour, with the apex red. The riblets are oblique, a little wavy, and about eighteen in number on the penultimate whorl.



## 19. DIPLOMMATINA SYMMETRICA. (Pl. XXV. fig. 19.)

Testa dextrorsa, imperforata, fusiformi-ovata, pallide lutea, versus apicem rufescens; anfractus  $7\frac{1}{2}$ , perconvexi, regulariter crescentes, sutura profunda sejuncti, costulis tenuissimis lamelliformibus breviter obliquis numerosis instructi, inter costas læves, ultimus penultimo subangustior, contractus; apertura parva, subcircularis, cum perist. longit. totius  $\frac{2}{3}$  adæquans; peristoma duplex, luteum, margine externo valde incrassato, ad columellam angulatim producto, supra parietem tenui.

Longit.  $3\frac{1}{2}$  millim., diam  $1\frac{1}{2}$ . Apertura cum perist. 1 longa.

*Hab.* Gomanton Hill, N. Borneo.

*D. Aldrichi* of Godwin-Austen is allied to this species, but is more tapering above and has a different peristome and a stronger columellar tooth. The lamellæ are about eighteen in number on the penultimate volution.

## 20. DIPLOMMATINA EXCENTRICA. (Pl. XXV. fig. 20.)

Testa dextrorsa, imperforata, irregularis, distorta, sordide albida, versus apicem pallide rufescens; anfractus 7, convexi, primi quinque regulares, penultimus excentricus, sinistrorsum constrictus, omnes lamellis tenuissimis subremotis, leviter obliquis instructi; apertura mediocriter magna, irregulariter circularis, ad columellam subcanaliculata; peristoma duplex, margine interno crasso continuo, externo tenui lamelliformi superne subinterrupto, utrinque producto; columella obliqua, in medio dente conspicuo munita.

Longit. 3 millim., diam  $1\frac{1}{2}$ . Apertura cum perist. 1.

*Hab.* Molu or Mulu Mountain, N. Borneo.

This species is remarkable for its distorted aspect, occasioned by the remarkable constriction and bulging of the penultimate whorl. The peristome is conspicuously produced both on the right side of the aperture and at the base of the columella.

## 21. DIPLOMMATINA EVERETTI. (Pl. XXV. fig. 21.)

Testa dextrorsa, imperforata, subpellucida, sordide albida, ad apicem rufescens; anfractus 7, convexi, lamellis tenuissimis subdistantibus flexuosis ornati, primi quinque regulares, quintus latus, angulatim rotundatus, penultimus maxime constrictus, distortus, lævis; apertura irregulariter rotundata; peristoma duplex, pallide luteum vel albidum, paulo expansum, ad basim columellæ productum; columella rectiuscula, in medio dente parvo acuto munita.

Longit.  $3\frac{1}{2}$  millim., diam fere 2. Apertura cum perist.  $1\frac{1}{4}$  longa.

*Hab.* Barit Mountain, N.W. Borneo.

This species is a trifle larger than *D. excentrica*. When viewed with the aperture to the eye, the penultimate whorl is a

mere plain band or constriction, and does not bulge laterally as in the species referred to. The peristome also is less produced on the upper outer margin.

22. *DIPLOMMATINA BARITENSIS*. (Pl. XXV. fig. 22.)

Testa dextrorsa, imperforata, subpellucida, albida, ad apicem rufescens; anfractus 7, tenuissime lamellati, perconvexi, sutura profunda discreti, primi quinque lente accrescentes, penultimus maximus, subito inflatus, ultimo latior; apertura subcircularis, latere columellari rectiusculo, dente minuto submediano instructo; peristoma duplex, margine externo tenui utrinque angulatum producto.

Longit.  $2\frac{3}{4}$  millim., diam.  $1\frac{1}{2}$ . Apertura cum perist.  $1\frac{1}{2}$  lata.

*Hab.* Barit Mountain, N.W. Borneo.

The spire of this species above the penultimate whorl is much narrowed and obtuse at the tip; the penultimate is considerably bulged out and has a slightly distorted appearance when viewed both in front and behind. It differs from *D. Aldrichi*, Godwin-Austen, in form and in the character of the lip of the aperture.

23. *ARINIA BORNEENSIS*. (Pl. XXV. fig. 23.)

Testa minuta, pupiformis, umbilicata, sordide albida, ad apicem rufescens; anfractus 5, sutura profunda sejuncti, convexi, liris numerosis tenuibus obliquis ornati, ultimus latitudine penultimum subæquans, antice paulo ascendens; apertura circularis, parva; peristoma duplex, expansum, album, margine externo superne utrinque interrupto, haud continuo, lamelliformi.

Longit.  $1\frac{3}{4}$  millim., diam. 1. Apertura cum perist.  $\frac{3}{4}$  lata.

*Hab.* Gomanton, North Borneo.

The well-expanded inner margin of the peristome has a conspicuous lamella outside it, forming, as it were, a double lip. The fine oblique liræ become gradually finer as the apex is approached.

24. *ARINIA SIMILIS*. (Pl. XXV. fig. 24.)

Testa minuta, breviter pupiformis, umbilicata, sordide albida, apicem versus rufescens; anfractus 4, convexi, sutura profunda discreti, liris tenuibus obliquis, primo confertis deinde remotioribus, ornati, ultimus latitudine penultimum æquans; apertura subcircularis; peristoma duplex, mediocriter validum, marginibus callo tenui lato junctis.

Longit.  $1\frac{1}{2}$  millim., diam fere 1. Apertura cum perist.  $\frac{1}{2}$  lata.

*Hab.* Barit Mountain, N.W. Borneo.

This species is a little smaller than *A. borneensis*, consists of

a whorl less, and has the liræ much closer together on the penultimate and preceding whorls. The peristome also is not so developed as in that species.

25. *GEORISSA GOMANTONENSIS*. (Pl. XXV. fig. 25.)

Testa imperforata, ovato-turbinata, dilute citrina; anfractus 4, convexi, sutura profunda sejuncti, striis spiralibus tenuibus confertis sculpti; apertura semicircularis, longit. totius  $\frac{1}{2}$  haud æquans, intus pallida; peristoma leviter incrassatum, sordide albidum; columella obliqua, callo supra umbilicum reflexo induta.

Longit.  $2\frac{1}{4}$  millim., diam.  $1\frac{3}{4}$ . Apertura 1 lata.

*Hab.* Gomanton, N. Borneo.

This species is of a pale greenish-yellow colour, and there are traces of oblique whitish streaks, but, having only a single specimen to judge from, it is impossible to say if this is a constant character.

26. *GEORISSA SIMILIS*. (Pl. XXV. fig. 26.)

Testa minuta, obtecte perforata, ovato-turbinata, pallide rufescens, versus apicem saturatior; anfractus  $3-3\frac{1}{2}$ , convexi, incrementi lineis obliquis (in anfr. ultimo conspicuis) instructi, ultimus rotundatus; spira conica, ad apicem obtusa; peristoma leviter incrassatum, rubrum; columella leviter obliqua, rectilinearis, callo supra umbilicum reflexo induta; apertura semicircularis, longit. totius  $\frac{1}{2}$  subæquans.

Longit. 1 millim., diam.  $\frac{2}{3}$ . Apertura  $\frac{1}{2}$  longa.

*Hab.* Gomanton Hill, N. Borneo.

This species is somewhat similar in form to *G. Hungerfordi* of Godwin-Austen, but differs entirely in sculpture. The name *Hungerfordi* being already preoccupied by Möllendorff in 1885, for a Chinese species, I would propose to substitute that of *G. Lowi* in memory of Sir H. Low, who collected the specimens.

27. *GEORISSA HOSEI*, *Godwin-Austen, Proc. Zool. Soc.* 1889, p. 353, pl. xxxix. fig. 11. (Pl. XXV. fig. 27.)

Testa minuta, turbinata, obtecte perforata, rufescens; anfractus  $2\frac{1}{2}-3$ , primus lævis, globosus, penultimus convexus superne humerosus vel carinatus, ultimus quoque carina secunda ad peripheriam cinctus; carinæ peculiariter crispatae; anfractus duo ultimi spiraliter striati; apertura semicircularis, longit. totius  $\frac{1}{2}$  adæquans; perist. vix incrassatum, rufum; columella obliqua, rectilinearis, callo supra umbilicum reflexo induta.

Longit.  $1\frac{1}{2}$  millim., diam.  $1\frac{1}{3}$ . Apertura  $\frac{3}{4}$  longa.

*Hab.* Jambusan, N.W. Borneo.

This species is readily distinguishable by the shouldered character of the two last whorls, and the crispate keel which marks the cingulation, and the second carina upon the body-whorl. The above description is taken from smaller specimens than the two described by Colonel Godwin-Austen. The latter have the same peculiar crispate keels which I have described, but, having developed an additional whorl, have a different aspect as regards form.

#### EXPLANATION OF PLATE XXV.

Fig.

1. *Nanina (Xesta) moluensis.*
  2. *Sitala raricostulata.*
  3. „ *baritensis.*
  4. „ *moluensis.*
  - 5, 5a. *Cyclophorus Everetti.*
  6. *Lagocheilus baritensis.*
  7. „ *jucundus.*
  8. „ *inornatus.*
  9. „ *altus.*
  - 10, 10a. „ *borneensis.*
  - 11, 11a. *Opisthostoma mirabile.*
  - 12, 12a. „ *Everetti.*
  - 13, 13a. „ *jucundum.*
  - 14, 14a. „ *Wallacei.*
  - 15, 15a. „ *baritense.*
  - 16, 16a. „ *busauense.*
  17. *Diplommatina sulphurea.*
  18. „ *moluensis.*
  19. „ *symmetrica.*
  20. „ *excentrica.*
  21. „ *Everetti.*
  22. „ *baritensis.*
  23. *Arinia borneensis.*
  24. „ *similis.*
  25. *Georissa gomantonensis.*
  26. „ *similis.*
  27. „ *Hosei.*
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On the Affinities of the Genus *Madrepora*.

By GEORGE BROOK, F.R.S.E., F.L.S.

[Read 15th December, 1892.]

THE Linnean genus *Madrepora* was restricted approximately to its present limits by Lamarek, although as now understood it includes certain species which were referred by him to the genera *Oculina* and *Astræa*. Although few genera of corals appear so well defined and so readily recognized, its relation to other genera of the Perforata is a question on which there has been much diversity of opinion. Dana, in 1848, instituted a family Madreporidæ for the reception of the genera *Madrepora* and *Manopora* (= *Montipora*, Oken, which has priority). Klunzinger (1879) and Ridley (1884) have since adopted this arrangement. On the other hand, Milne-Edwards and Haime (1860) separated the two genera by a considerable interval in the classification which they proposed. According to these authors the family Madreporidæ should have a much wider range and include three subfamilies, viz. :—Eupsamminæ, Madreporinæ (confined to the genus *Madrepora*), and Turbinariinæ. They proposed that the genus *Montipora* should form a subfamily (Montiporinæ) of the Poritidæ. Verrill in 1865 also included *Montipora* with the Poritidæ and placed *Madrepora* and *Turbinaria* in separate families. In 1868, however, he followed Dana in associating *Madrepora* and *Montipora* together in one family. Duncan, in his Revision of the Madreporaria, read before this Society in 1885, followed Edwards and Haime in the association of *Montipora* with the Poritidæ, but extended the family Madreporidæ so as to include *Turbinaria*, *Astræopora*, and their fossil allies. Quelch has proposed still different limits for the family Madreporidæ, which he regards as including the following recent genera :—*Madrepora*, *Turbinaria*, *Astræopora*, *Anacropora*, *Montipora*. Finally Ortmann has recently (1890) proposed a new classification of the Madreporaria in which the genera *Madrepora* and *Montipora* rank as families ; the former is placed between the Alveoporidæ and the Eupsammidæ, the latter between the Turbinariidæ and the Poritidæ.

A discussion of the affinities of the genus *Madrepora* may appropriately commence with a criticism of the views of Duncan

as to the interrelationships of the genera *Madrepora*, *Turbinaria*, *Montipora*, and *Porites*. The only essential distinction between the families Madreporidæ and Poritidæ, according to the diagnoses given by Duncan, is to be found in the condition of the septa; in the Madreporidæ these are stated to be lamellar, slightly porous, or solid; in the Poritidæ never completely lamellar and often trabecular. This distinction may be satisfactory so far as *Turbinaria* and *Porites* are concerned, but would probably not have been regarded by Duncan as the most important difference between the two genera. In my experience the distinction does not hold good for all species of *Madrepora* and *Montipora*. In *Madrepora* one frequently meets with specimens in which the septa are not lamellar, especially in species in which they are never well-developed, and on the other hand many species of *Montipora* have well-developed lamellar septa. Duncan noted in an earlier paper, which will shortly be referred to, that in the genus *Madrepora* the septa are first recognizable (in bud-corallites) as longitudinal series of spinose trabeculæ projecting inwards from the thin porous wall; and I find that in some species the lower part of the septa never passes beyond this stage. The condition of the septa thus furnishes evidence for the union of *Madrepora* and *Montipora* into one family rather than for their separation. On looking elsewhere for the family characters, one cannot fail to notice the close general resemblance between *Madrepora*, *Anacropora*, and *Montipora*, and their equally distinct separation from *Turbinaria* and its allies on the one hand and *Porites* and its allies on the other. Indeed the separation into three groups is so marked that, excepting in the trabeculate origin of the septa, one fails to find any close relationship between the genera *Montipora* and *Anacropora* and the remaining Poritinæ *in sensu* Duncan.

Duncan in 1884 gave an account of the structure of the corallum in certain species of *Madrepora*. He pointed out that in young corallites the wall has only one layer of mural tissue, which is costulate, finely serrate or echinulate exteriorly, according to the species. An increase in mural tissue takes place by the formation of a new layer around the costulate or echinulate surface, in such a way that the costulæ or spinules act as props for the newly-formed layer, and the space between adjoining props is converted into a more or less completely closed chamber.

In transverse section "concentric circles of thin calcareous structure are seen, separated by radiating linear pillars; the circles having been in turn outside wall and the radii either spinules or costæ." If the coral is old the inner circles of tissue next the septal cavity are dense. Duncan also pointed out that no communication exists between the cavities of bud and axial corallites "except in a very indirect manner and through the medium of the dermal structures. . . . Budding takes place remote from the calicular margin and may arise from sclerenchyma remote from the wall of a corallite." Thus the density of the corallite depends to a great extent on the breadth of the so-called costæ and is always densest where the costæ are replaced by fine echinulations.

A further point remains to be noticed which appears to me important. As a result of the peculiar mode of budding in the genus *Madrepora*—which leads to the formation of a type of colony termed "patrioramose" by Dana—there is no cœnenchyma in the true sense of the word excepting at points where the colony is incrusting. The radial corallites are arranged on the branches at variable intervals, and the space between them is usually considered to consist of cœnenchyma; but these intervals really form part of the thickened wall of the axial corallite around which the radial corallites are developed, and the trabecular network of which they are composed is not precisely comparable with the interzooïdal cœnenchyma of *Turbinaria*, for example, which is a true secretion of interzooïdal tissue and not of the walls of the zooïds themselves.

The skeletal structure of the genera *Anacropora*, *Montipora*, *Porites*, and *Turbinaria* has hitherto received little attention. I have not as yet made a complete study of the question; the following notes are based on the study of only one or two species in each genus and, though sufficient for my present purpose, may need revision later. In *Anacropora* and branching species of *Montipora* the axis of a branch is occupied by elongate fibrous trabeculæ similar to those which constitute the trabecular type of columella in most genera of Madreporaria. Around this axial mass a network of shorter processes occurs in which the corallites are embedded; the intervals between the corallites consist of true cœnenchyma. The mode of budding is intercalicular but apparently the individual corallites remain directly connected together; in any case the stolon-like canals by which they are

united is not so intricate as in *Madrepora*. In lobose species of *Porites* the centre of each lobe consists of an open network of tissue, and the peripheral parts in which the corallites are imbedded has a similar structure, but the corallites are shallow and differ considerably in structure from those of *Montipora*. In *Porites* and its allies the budding may be inter- or intra-calicular and the corallites remain in direct communication with one another. Owing to the fact that the walls of adjoining corallites become fused together, there is little or no cœnenchyma between them. In the case of *Turbinaria* budding takes place by means of serial, radially-directed stolons, each more distal corallite being directly connected with the base of the one behind it. The radiating series of corallites are connected together by true cœnenchyma.

It will next be necessary to give a short summary of the structure of the soft tissues so far as this is known at present. Fowler has studied two 'Challenger' species, in one of which an interesting and new type of dimorphism occurs. The following short summary of his results gives the chief points of interest for my present purpose.

1. The external body-wall consists of ectoderm, mesoglœa, and entoderm. Under this and between the costæ a series of external longitudinal canals exists, which open into each other and also through the corallum into a series of internal canals with radial and transverse connections; these in turn communicate with the general cœlentera of the polyps, and all communicate eventually with the cœlenteron of the axial polyp.

2. The structure of the polyps is in its general features Actinian, but there is a marked bilateral arrangement of the parts. The septa are probably entocœlic. There are twelve mesenteries; six are short, the others longer, but two of these are very long and are the only ones which bear reproductive organs. Similar elongate mesenteries occur in *Alcyonaria*, in *Antipatharia*, and in *Seriatopora* and *Pocillifera* amongst the Madreporaria. In *Antipatharia*, as in *Madrepora*, they are the only ones which bear reproductive organs.

Since the publication of Fowler's observations, our views as to the homologies of the mesenteries of *Zoantharia* have undergone considerable modification, due more especially to the researches of Haddon and McMurrich on Actiniaria and my own on Antipatharia. Fowler's division of the peripheral portions of the



polyp-cavity into endocœles and exocœles is only applicable to forms in which the mesenteries are arranged on the Hexactinian plan, *i. e.* in so-called pairs consisting of adjacent mesenteries. The development of mesenteries in such pairs only commences after the first twelve are formed. Up to that point the arrangement is bilateral and members of a pair are situated on opposite sides of the stomodæum; the only ones which come to form pairs in the Hexactinian sense are the directives. It therefore now appears necessary to make use of another term to distinguish the inter-mesenterial chambers in bilateral types with 6, 8, 10, 12, or more mesenteries, and the word "amphicœle" appears suitable. I would use the term in all cases of Anthozoa where the lateral divisions of the cœlenteron are brought about by the formation of mesenteries arising from opposite sides of the stomodæum and where in consequence the chambers are simply intermesenterial; in other words, in homocœlic as distinguished from heterocœlic types. In such cases the position of the retractor muscles of the mesenteries is variable and may or may not correspond with the Hexactinian arrangement. In the case of *Madrepora* the arrangement is Hexactinian, that is to say the mesenteries are arranged in real or apparent pairs, having the retractor muscles on their outer surfaces in the case of the directives and on the inner surfaces in all other cases. Using Fowler's terminology the primary septa (6) are, in *Madrepora*, endocœlic, the secondary cycle (6) exocœlic. Although the development of *Madrepora* is not known, I think one is justified from our knowledge of the development of Hexactinians, and Haddon's observations on the embryo of *Euphyllia*, in concluding that in the final arrangement only the directive mesenteries arose as pairs and that the other pairs consist of mesenteries situated on opposite sides of the stomodæum. In this case the arrangement of the retractor muscles does not indicate the true relationship of the lateral mesenteries and all the septa should be described as amphicœlic.

I would also suggest that the septa situated between the "directive" mesenteries be known as the "directive" septa, as they indicate the long axis of the stomodæum and are the first to indicate a bilateral arrangement of parts in the skeleton. It is often stated as characteristic of the genus *Madrepora* that the directive septa are more prominent than the other primaries; but this is by no means always the case, nor is the feature con-

fined to the genus. One frequently finds that in radial corallites the outer directive septum is broad and the other five primaries equal. In other species the primary septa of both axial and radial corallites are of equal breadth, in which case the bilateral arrangement of parts in the polyp is not indicated by the relative importance of the directive septa. Unfortunately we yet know little of the structure of the polyps in the genera *Anacropora* and *Montipora*, but the relative importance of their septa is subject to the same variations as in *Madrepora*. In *Anacropora* the corallites are prominent, and the branches resemble those of *Madrepora* so closely that it is not until the absence of an axial corallite is observed that the generic distinction is realized. In this genus the directive septa are usually broader than the others. In *Montipora* the septa are sometimes all rudimentary, but in other cases the directives are very broad and may even meet in the middle line to form a false columella such as occurs in certain species of *Madrepora*. A bilateral arrangement of parts is thus as well marked by the septa of *Anacropora* and *Montipora* as in *Madrepora*, and one may infer a somewhat similar structure in the polyps. The polyps of *Porites* have not been studied, but they bear no external resemblance to those of *Madrepora*. Fowler also has shown that the polyps of *Turbinaria* do not conform to the *Madrepora* type.

Ridley, in 1884, discussed the mode of budding in *Madrepora* and *Montipora*, and considered that there is a fundamental difference between the two types, dependent on the terminality or non-terminality of the distal corallite. He pointed out that *Isopora*, Studer (a subgenus of *Madrepora*), is not without apical corallites as had been supposed, but that each lobe is provided with several instead of one. In both *Madrepora* and *Montipora* there is a more or less abundant trabeculate cœenchyma. In *Madrepora* the budding is centrifugal, *i. e.* new buds arise below the apical corallite. In *Montipora* the apex consists of undifferentiated cœenchyma and new buds are added above those existing, *i. e.* centripetally. He compared the condition to determinate and indeterminate inflorescence. The mode of budding in *Anacropora* is the same as in the genus *Montipora*. Ridley therefore suggests the establishment of two subfamilies, Madreporinæ and Montiporinæ, with characters based on this distinction.

The terms "centrifugal" and "centripetal" do not appear to

express accurately the precise modes of budding to which they are applied, and it would probably have been better had Ridley employed the botanical terms "determinate" and "indeterminate" to express the distinction in the case of branching species. In foliate species of *Montipora* the budding is centrifugal not centripetal, seeing that new corallites are added at the periphery. In branched specimens of *Madrepora* the buds arise around and are indirectly connected with an elongate corallite forming the axis of each branch and extending from its point of origin to the apex, where it always projects more or less. This corallite, often spoken of as the parent corallite, is usually of larger diameter than the others and often exhibits a better-developed series of septa. It is usually termed the apical corallite ("Endkelche," by the Germans), but axial corallite seems much more appropriate; the part of it which is "apical" and recognizable in surface view is only an insignificant part of its whole length. For similar reasons I propose to replace the term "lateral" corallite by "radial" corallite, excepting in the rare instances when these are arranged in lateral series on a flattened branch.

Although the types of budding indicated by Ridley form an essential distinction between *Madrepora* and *Montipora*, the type characteristic of *Madrepora* is confined to branches formed by the living colony during its growth: in other situations the buds are formed in a similar manner to those of *Montipora*. In specimens which form incrustations,—and all are incrusting in the first instance—new corallites are added peripherally from an undifferentiated mass of tissue which projects beyond existing corallites. It is only when certain of the corallites increase in length and thickness, so as to indicate the first formation of branches, by the development of buds around them, that the form of budding characteristic of *Madrepora* comes into operation. Frequently both types of budding take place at the same time in one colony; the one leads to branch formation, the other to marginal or basal extension. One not infrequently meets with specimens in which a colony of a younger generation forms an incrustation over the branches of a dead colony of the same species. In such cases new corallites are added from a marginal mass of undifferentiated tissue until the apex of the dead branch is reached, and only later, when independent growth begins, is the mode of budding changed. It also seems probable that the

immersed corallites which frequently occupy the lines of fusion between adjoining branches are formed by the primitive and not by the specialized mode of budding.

The classification of Actiniaria and Antipatharia is largely based on the structure of the polyps, and it seems extremely probable that before a natural classification of the Madreporaria is possible, much more information on this point must be available. In many cases difference of structure in the polyps is no doubt associated with a distinctive type of skeleton, but at present we are unable to use these characters to the best advantage. Still the marked bilateral arrangement of the septa in *Anacropora* and many *Montipora* appears to indicate an affinity with the genus *Madrepora* which, so far as we know at present, is not shared by any other genus. It therefore seems desirable to inquire whether Dana's views should be accepted as modified by Ridley, or whether we should regard *Madrepora* and *Montipora* as members of distinct, though closely allied, families.

*Madrepora*, with its axial corallites and radial bud-corallites, stands alone, and, so far as I am aware, there is no approach to this mode of colony formation in any other genus, taking into consideration the indirect means by which it is attained and the consequent absence of true cœenchyma. It is also evident that both *Madrepora* and *Montipora*, as at present understood, will sooner or later be considerably subdivided, so that for purposes of convenience the course adopted by Ortmann has its advantages. The point, however, remains that the characteristic mode of colony formation in *Madrepora* is confined to the formation of independent branches and that at first in all colonies, and always so long as incrustation continues, the mode of budding is not characteristic. On this account it appears reasonable to suppose that the species of *Madrepora* form a specialized group which indicate their affinities in the incrusting stage. A final decision can only be arrived at when we know much more about the structure of the polyps and their relation to the skeleton which they produce; but in the meantime I prefer to adopt the course suggested by Ridley and divide the Madreporidæ into two sub-families:—

Madreporinæ—gen. *Madrepora*.

Montiporinæ—gen. *Anacropora*.  
gen. *Montipora*.

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On two new Species of *Rhax*. By HENRY M. BERNARD, M.A., Cantab. (From the Huxley Research Laboratory, Royal College of Science, London.) (Communicated by W. PERCY SLADEN, Sec. Linn. Soc.)

[Read 2nd February, 1893.]

(PLATE XXVI.)

IN furtherance of researches which I am now carrying on in the above-mentioned laboratory on the Galeodidæ, specimens were obtained from the well-known naturalist, Herr Fric, of Prague. Two of them were labelled "*Aellopus*, sp., from Vellore, Madras, found by the missionary Lövendal." The third was unnamed, but Herr Fric informs me that it was found near Geogh Teppe by an engineer who had been with General Anenkov during the construction of the Transcaspian railway. The specimens, however, were not the extremely rare *Aellopus*, but two different species of *Rhax*, both of which appear to be new.

*RHAX NIGROCINCTA*, n. sp. (Pl. XXVI. fig. 2.)

There are two specimens, the sexes of which are not easy to determine without dissection. One has a very much distended abdomen; but this I have found may be due to a large meal, and does not necessarily mean that the animal is a pregnant female distended with eggs. Again, the absence of flagella on the mandibles is no criterion of sex; for although it is generally stated that these organs are confined to the males, I have found them on a specimen of *Galeodes græcus*, Koch, which, on dissection, proved to be a female.

The normal length is about  $1\frac{1}{4}$  inch, while the specimen with distended abdomen measures 2 inches. The nearest species I can find is *R. annulata*, Simon \*, which, however, is only 18 millim. long. This animal has very nearly the same black markings round the limbs as I have figured for *Rhax nigrocincta*, only the rings on the second, third, and fourth legs in the latter are on the tibia, and not on the femur as described for *R. annulata*; and the second ring on the third leg is on the metatarsus, and not on the tibia. Simon makes no mention of the very conspicuous triangular white patches at the anterior margin of the "head."

Simon's description of the colouring of the abdomen in *R. an-*

\* Bull. Soc. Zool. x, p. 2.

*nulata* does not seem to resemble very closely that of *R. nigrocincta*, which has an apparently continuous broad yellowish-white band down the middle dorsal line; but in the specimen with distended abdomen the anterior margins of the segments are also seen to be coloured. The red-brown colour of the rest of the abdomen is deeper on the ventral surface, the difference between the two shades being sudden and sharp. A regular dark band along the ventral abdominal surface seems common to many species of *Rhax*. Simon describes the anal segment in *R. annulata* as black: in *R. nigrocincta* the prevailing colour of the segment is olive-green; it is covered with minute wart-like protuberances, with white tips.

Of other characters employed by Simon\* for the classification of these animals, I may mention that the ocular tubercle is oval and transverse, the eyes are small, and the interval between them is somewhat larger than the diameter of the eyes themselves.

*RHAX* HOWESII, n. sp. (Pl. XXVI. fig. 1.)

This species differs in several important points from the foregoing. While the "head" and chelicerae are of the same colour, the anterior edge of the former is marked by a pure white line, hardly distinguishable from the white articulating membrane of the mandibles, which shows very conspicuously at their bases. The thoracic segments behind the "head" are pure yellowish white, as are the legs, which latter have no trace of the black rings characteristic of the Gundacul and the Vellore species (*R. annulata*, Simon, and *R. nigrocincta*, n. sp.). The pedipalp and the first pair of legs are, however, tipped with purplish brown, and have a broad band of the same round the femur. The colouring of the abdomen, again, is different from that of any *Rhax* of which I have been able to find a description. The dorsal surface is purplish brown without any median white band: the colour gets lighter laterally till the ventral surface is quite light, but spotted with darker patches so arranged as to appear to be the remains of the dark band of colour so common on the ventral surface in this genus. The anal segment is dark purplish black round the anus itself, while its anterior margin is yellowish white. The segment preceding the anal segment is entirely

\* "Essai d'une classification des Galeodes," Ann. Soc. Ent. Fr. (5<sup>e</sup> sér.) t. 9 (1879).

yellowish white, which colour spreads dorsally forwards to form a triangular patch ending in a blunt point on the fourth segment from the last.

The ocular tubercle is very smooth, of a bright green colour, oval and transverse, the eyes being larger than in the last-named species, and the interval between them being decidedly less than their diameter.

The nearest species I can find to this is *R. melanopyga*, Walter\*, but there are differences which must, at least at present, be considered as specific. For instance, in *R. melanopyga*, the white patch round the anus runs forward right along the dorsal abdominal surface; it, however, shows signs of narrowing before reaching the cephalothorax. The colour on the femora of the pedipalps and first legs in *R. melanopyga* is described by Walter as a smoke-grey (*Rauchgrau*); this smoke-grey must have been very faint, as the zoological artist Sokolovski has not given a hint of it in his drawing; all the legs are a uniform yellow.

In the case of each of these new species, that nearest in character is also nearest in geographical distribution. The new *R. nigrocincta* and the *R. annulata* of Simon, with which it is most nearly akin, were both found in India, about 200 miles apart. And, again, Dr. Walter's *R. melanopyga* was found by him near Askabad, 50 miles from Geogh Teppe.

As long as the animals remain so rare it is obviously futile to discuss the question as to whether any new discoveries are only varieties or new species. Provided they are sufficiently distant from one another, and show any striking differences of coloration, there is nothing for it but to label them as new, leaving it to future discoverers of the transition forms to draw the lines between the species.

The specimens shown in Plate XXVI. have been deposited as types in the Natural History Museum at South Kensington.

#### EXPLANATION OF PLATE XXVI.

Fig. 1. *Rhax Howesii*. Dorsal and ventral aspects.

2. *Rhax nigrocincta*. Dorsal and ventral aspects.

N.B.—In the drawings the femora of the first and second limbs have been foreshortened.

\* Zool. Jahrb. iv. pt. 1, pp. 1095-1109.

On the Structural Differentiation of the Protozoa as seen in Microscopic Sections. By J. E. S. MOORE, A.R.C.S. (From the Huxley Research Laboratory.) (Communicated by Prof. G. B. HOWES, F.L.S.)

[Read 2nd February, 1893.]

(PLATE XXVII.)

OUR knowledge of the more minute structure of the Protozoa has considerably increased of late, this increase being no doubt due, in a great measure, to the introduction of the new apochromatic lenses as well as to the modern methods of fixation and differential staining. It is by these means that the protoplasmic contents of *Amæba*, for example, have been resolved into something more than a structureless hyaloplasm and its suspended granules; and we have grown conscious of an immensely complicated vacuolation stretching from the large ingestion-spaces on the one hand to the ultimate "Schaumplasm" [the heterogeneous foam structure of Bütschli] on the other. And, again, it is in the internal tensional activities of such structures that this author seeks for a possible mechanical substratum of some of the simpler vital phenomena. More recently, and apart from all hypotheses, F. Schütt\*, by means of optical sections through a number of *Peridinia*, has not only demonstrated the existence of remarkable spaces ("Saftkammern"), but a veritable excretory system in connexion with them; while Prof. Greeff†, by substituting actual sections of *Amæbæ* for the optical sections of *Peridinia*, has brought to light a radial structure extending through the ectosarc and intimately connected with the contractility of the animal as a whole. In fact, if his observations can be confirmed, they mark the starting-point of a new era in our knowledge of the minute Protozoan anatomy.

It is with an extension of such an analysis, by sections of the ultimate Protozoan structure, that the following short contribution is concerned. Undoubtedly the material at my disposal will appear very limited; but the character of the technique became so forbidding in the case of forms not attainable in vast numbers,

\* 'Sitzungsberichte der königlich preussischen Akademie der Wissenschaften zu Berlin,' 1892, xxiv. pp. 377-383.

† Dr. Greeff, "Ueber den Organismus der Amöben," Sitzungsberichte der Gesellschaft zur Beförderung der gesammten Naturwissenschaften zu Marburg, 1890, pp. 21-25.



that anything like even a preliminary survey of the leading Infusorian types would occupy much time, even years: however, as the results with some of those more easily manipulated were novel and interesting in themselves, I thought it worth while to publish them as a short preliminary essay.

After some trials I succeeded in obtaining sections in series of *Spirostomum*. The animals were killed by osmic acid, or by heating and afterwards fixing in Flemming's or Hermann's solution, in which they remained for twelve to eighteen hours, and were then transferred to a tall tube, from which the supernatant liquid was repeatedly decanted and replaced by distilled water for some hours. After the last filling up the water was poured off and alcohol added very gradually, in order to prevent contraction of the delicate sarcode, until a 50-per-cent. solution was reached, in which the Infusoria remained like a coarse precipitate at the bottom for twelve to eighteen hours more. The strength of the spirit was then increased until the whole was gradually replaced by absolute alcohol. It made no difference as to the ultimate result whether the objects were treated with cedar oil or chloroform and then transferred to paraffin. So soon as the Infusoria had settled in this last and it had been replenished two or three times, the larger part of the fluid was poured off and the remainder, with the Infusoria, shaken up slightly and cast in the usual manner. The sections were cut in the usual way with a Minot microtome and stained as required.

*Spirostoma* treated in the above manner and stained with either gentian-violet, Victoria blue, or orange, showed a splendid reticulum or vacuolation (quite invisible except in section) of the whole protoplasmic body (sarcode) (Pl. XXVII. figs. 2, 3, 4). The meshes of this reticulum were finer round the nuclei and largest between these structures and the periphery, where they died down to a compact protoplasmic layer just within the actual outer membrane. This layer undoubtedly corresponds to what Schütt described in *Peridinium* as the "Hautschicht." It is no less obvious that the large vacuolations correspond to his "Saftkammern" and the intervening reticulum to his "Füllplasma." The remarkable radial structures of Greeff were not apparent, but something, at least, suggestive of his "glänzende Punkte" [fine refracting particles], in which this radial structure terminated, are seen underlying the apices of the longitudinal ridges (fig. 8, a).

These sections appear to indicate the existence of denser tracts

of substance running down the entire length of each ridge, or in reality an apparently resistant structure which may have much to do with the rapid undulations and contractions of the animal when in activity. Still more interesting in relation to these appearances were a series of sections across the oral furrow from its anterior extremity until it finally dips into the inner sarcodē by a distinct ostium (fig. 4). This furrow contains at its bottom a little ridge; and immediately below this is a dense rod similar to those above, only much larger in section (fig. 6, *a*). The ridge bears, above, the well-known oral cilia along its whole length, and the rod appears to act as a support for the whole ciliary apparatus. The sarcodē is more firmly in connection with the inner edge of this rod than the surrounding parts, and there appear faint refractive lines running from this inwards (fig. 6, *b*). I cannot understand the significance of these refractive striæ unless the fibrillation represents the agent in transmission of something like a nervous impulse from the inner protoplasm to a specially mobile region.

When subjected to a precisely similar treatment, the protoplasmic body of *Paramœcium* shows no such differentiation into a reticulum of chromatic fibres and achromatic spaces as that described above. Their contents are far more nearly uniformly made up of granular protoplasm imbedded in which are seen the food-stuffs as more deeply-staining masses. At the same time there do appear about the huge macronuclei irregular spaces and lacunæ having no immediate connexion with the contractile vacuole, which are undoubtedly analogous to the more numerous spaces ("Saftkammern") in *Peridinium*. Consequently they must be looked upon as all that is left of the splendid protoplasmic network of the *Spirostoma*.

The dying out of the necessity of such a reticulum, through forms like *Peridinium* to the *Paramœcia*, is a very curious fact, and it shows, I think, that we have not yet done with protoplasmic reticula, at any rate in the sense of their significance.

Irregularly disposed throughout all the internal reticula of *Spirostomum* are innumerable small refractive dots. They appear along the fibres of the network and become more numerous towards the periphery on all sides (fig. 3). With care they are to be seen in the interior of the living animal, and in sections appear closely connected with the double spiral rows of dots characteristic of the species. I have elsewhere\* described the

\* Ann. & Mag. N. Hist. 6th ser. vol. xi. p. 149.

relation existing between the primarily ingested food in *Amœbæ* and the so-called crystalline bodies underlying the ectosarc, and have suggested that they may be the insoluble residue of the animal's prey. Some observations (as yet unpublished) of my friend Mr. Bernard on the digestive cells of the blood-sucking Arachnids have strongly confirmed this view, and it seems probable that these refractive dots are the last residuum of the animal's food, and that as such they make their way out along the lines of the enclosing membrane.

I have hitherto made no allusion to any relation existing between the condensations I have described beneath the external rugæ and Haeckel's myophan striation, simply because the more closely I sought after it the more distant any such relationship appeared: in fact these structures appear to be rather complementary or antagonistic than homologous. As Haeckel describes them, the myophan striations "erscheinen als ein System von regelmässigen, parallelen, finen Streifen . . . . . dicht gedrängt neben einander verlaufen, und abwechselnd heller und dunkler erscheinen" \*; and according to this author, these structures lie at the base of his ciliary or second layer, and themselves constitute the third layer †. Now the condensations I have described are embedded in the ciliary layer itself, and are immediately below the not very distinct outer cuticle. In somewhat tangential sections the myophan striæ are seen to correspond exactly with the ditches between the superficial ridges, a fact pointed out by Entz ‡; while the denser rods described above are situated immediately beneath the apices of these ridges, and they consequently alternate with the myophan stripes. Thin sections do not demonstrate the existence of such contractile fibres forming a third layer, and the homogeneous character of the condensations to which I have drawn attention seem to suggest elastic, in contradistinction to contractile function, and to shift the responsibility of the latter on to the ciliary layer as a whole. It may here be remarked that this view would bring the contractility of the ciliate Infusoria into much closer harmony with that of the Rhizopods.

Since describing the cross section of the oral furrow and the comparatively large skeletal structure which lies beneath it, I

\* 'Jenaische Zeitschrift für Medecin,' Bd. vii. p. 535.

† Greeff considers them as hollow structures and speaks of the "Lumina der Muskelfasern."

‡ 'Zeitschrift für wissenschaft. Zoologie,' xxxviii. p. 167.

have made longitudinal sections of the same region. In these there appear, stretching across the denser band, refractive stripes which terminate externally in successive fans of cilia seen edge-wise, while internally these ciliary roots, so to speak, are related to a remarkable series of protoplasmic bodies terminating interiorly in the general network (fig. 7).

I have diagrammatically represented the relations of all these structures (fig. 9). It will be seen that the rods *b* (fig. 7) are the longitudinal expression of the fine striæ seen passing inwards from the fan of cilia (fig. 6, *b*), and stand as a means of connexion between the inner network and the bases of the cilia themselves. Whatever their function, I have now observed them in the living animal, and they appear to be permanently related to the ciliary apparatus.

#### EXPLANATION OF PLATE XXVII.

Fig. 1. *Spirostomum*, showing the relation of the oral furrow, *FO*.

2. Section showing protoplasmic network.
3. The same, showing refractive bodies between the spaces.
4. Section through mouth.
5. Section with food-matter recently ingested.
6. Cross section of oral furrow.
7. Longitudinal section of oral furrow.
8. Section showing the relation of the outer layers.
9. Diagram of the oral cilia and their related parts.

*a.* Dense rods in ciliary layer.

*b.* Protoplasmic bodies beneath the ciliary apparatus of pharynx.

*c.* Dense outer layer of inner protoplasm.

*c.v.* Contractile vacuole.

*n.* Nucleus.

*f.* Food-masses.

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Some Points in the Anatomy of *Melongena melongena*. By J. HENRY VANSTONE, Royal College of Science, S. Kensington.  
(Communicated by Prof. G. B. HOWES, F.L.S.)

[Read 16th March, 1893.]

(PLATE XXVIII.)

THE genus to which this Gasteropod belongs was founded by Schumacher in 1817 as a refuge for certain waifs from other genera. The shells of the genus have often been figured and described under the names of *Cassidula*, *Murex melongena*, *Pyrula melongena*, *P. tuba*, and *P. galeodes*. The structure of the animal, however, appears to have been ignored (so far as I have been able to ascertain) by all writers except the French conchologist Souleyet\*.

This naturalist, more than forty years ago, gave an account of the anatomy of *Pyrula tuba*, which is now placed in the genus *Melongena*. On reference to the description and figures it will be seen that *M. tuba* agrees in the main with the species now under consideration †.

Concerning the viscera Souleyet rightly remarks that "l'appareil digestif offre le plus grand analogue avec celui des Buccins, des Pourpes," and as in these Prosobranchs there is present a long proboscis which, when retracted, is folded upon itself (Pl. XXVIII. fig. 2 b). The radula, in common with that of other members of the Turbinellidæ, bears teeth in three series—a central tricuspid series and two lateral bicuspid rows.

The œsophagus ( $\alpha'$ , figs. 1–2) is long and narrow and throughout its distal half its internal walls are longitudinally plicated ( $\alpha'$ , fig. 4), as is the case in *Pteroceras* and certain allied forms. Souleyet remarks that in *Melongena tuba* the œsophagus, at first of small calibre, afterwards became dilated and "cette seconde partie de l'œsophage forme une sorte de prolongement cæcal;" but I have not observed either of these characters in *M. melongena*.

The stomach, which is remarkable in several points, lies (*st.*, fig. 1) packed away between the liver (*lv.*) and genital gland (*g.g.*) in the topmost whorls of the shell, and is generally left behind on the extraction of the animal. This organ is very small in

\* Souleyet, 'Voyage de la Bonite,' ii. 1852, p. 614.

† Unfortunately the specimens at my disposal had been imperfectly preserved, and consequently I have been compelled to confine my attention to certain parts of the alimentary canal.

proportion to the size of the animal's body, for in a specimen whose shell was 12 centimetres long and 8 centimetres broad at its widest part, the stomach only measured about 9 by 2·5 millimetres. In none of the specimens examined did the diameter exceed 3 millimetres. The calibre of this organ is but slightly in excess of that of the œsophagus and intestine, and in this it differs from *M. tuba*, in which the stomach is more expanded and sac-like.

The chief point of interest, however, is not seen until the stomach is opened, and if present in *M. tuba* it was overlooked by Souleyet. Within the stomach of *M. melongena*, on the upper and lower walls, there is a longitudinal series of hard cuticular plates and knobs lineally disposed on a median ridge (*p.g.' p.g.''*, figs. 3, 4). At the curvature of the stomach the rows take their origin in an irregular group of somewhat larger knobs and they are continued down to within a short distance of the opening of the bile-duct (*b.d.*, fig. 3). The above-mentioned œsophageal ridges bear, when near the stomach, long claw-like plates fixed only at their anterior ends. Both œsophageal (*p.œ.*, fig. 4) and gastric plates are freely movable on their bases of attachment.

In the stomach of two species of *Crepidula* \*, Haller has lately described swellings bearing a thickened projecting cuticle, and these he believes effect a retardation of the flow of food-material. These structures, from their general characters and position, must be the same as those met with in *Melongena*, where they are more strongly developed. The function of retardation in *Melongena* would, I think, be sufficiently ensured by the small calibre of the intestine, assuming that that function be necessary. It seems more probable that these tough, apparently chitinous, plates effect a trituration of the food, as is undoubtedly the case in *Pteroceras*, where similar cuticular processes exist †. The homology of the parts, as seen in *Pteroceras*, with the "sagitta tricuspidis" of Lamellibranchs has been pointed out by Barrois ‡

\* B. Haller, "Die Morphologie der Prosobranchier, iii.," *Morph. Jahr.* xviii. p. 502.

† T. H. Huxley, "Morphology of the Cephalous Mollusca," *Phil. Trans.* 1853, pp. 29, 66.

‡ T. Barrois, "Le stylet cristallin des Lamellibranches," *Revue Biol. du Nord*, 1890, No. 8, p. 310.

and others, and it seems reasonable to place the gastric plates of *Melongena* in the same category. The behaviour of these plates under the action of a few simple reagents has shown that chitin does not form a constituent, and also that their cuticular substance is similar to that of the "sagitta" and crystalline style, which in composition nearly approach mucin. These characters will be best expressed in a table :—

	KHO.	HCL.	Millon's reagent.	HNO <sub>3</sub> and NaHO.	CuSO <sub>4</sub> and NaHO.
Mucin .....	Soluble.	Soluble.	Proteid react.	Proteid react.	.....
Sagitta .....	"	"	"	.....	Proteid react.
Gastric plates.	"	"	"	.....	"

A histological examination of the gastric plates of *Melongena*, if the material had been better preserved, would have thrown light on their relations to the adjacent tissues ; but, as it happens, the condition of the parts did not admit of any definite interpretation. As seen in section, one of the gastric plates consists of a more or less hyaline matrix containing scattered cells (*ep.*, fig. 5) and nuclei. The cells vary much in shape, being either oval, circular, or fusiform, as shown in fig. 8. In one or two of the larger plates apparent lamellæ (*lm.*) occur, their lines of division appearing granular, and having the cells definitely arranged alongside. These lamellæ are not satisfactorily seen in the smaller plates. The basal part of each plate (*fb.*) assumes a fibrous character and passes gradually into the underlying structures, in which there is usually present a loose tissue containing lineally-disposed spaces. In one plate, at least, these spaces (*lc.*, fig. 5) will be found to decrease in size as they pass forwards, and the most anterior space becomes continuous with the line of division between two lamellæ. In many of the smaller sections there is present a dense and slightly fibrous layer (*sh.*, fig. 5) covering the cuticle (*ct.*). This investment in the smallest plates appears to be continuous with the intestinal epithelium (*ep.* of fig. 7), and in the larger ones it is absent from the greater part of the free surface. It has been, however, impossible to determine

the exact nature of this layer, as it and the neighbouring tissues were in an insufficiently preserved state\*.

The thickened cuticle in the stomach of *Crepidula*, according to Haller †, is perfectly homogeneous, without lamellæ, cells, or nuclei, and in these respects it differs from that of *Melongena*. In certain *Cestodes* (e. g. *Tania lineata*) there is present a lacunar tissue beneath the cuticle such as we have seen in *Melongena*, and its resemblance to the connective tissue of a mollusk has been shown by Griesbach ‡. The lacunæ are either empty or filled with granular contents, and both these conditions are met with in *Melongena*.

The structures which I have herein described are situated in the mesenteron, and are derivative of that portion of the alimentary canal, and they must therefore be distinguished from the plates and hooks met with in many other Gasteropods (e. g. *Aplysia* §), in which they occur in the parts derived from the stomodeum. These stomodeal plates, moreover, are chitinous in nature. Barrois compares the "sagitta" of the Lamellibranch and its representatives above the Gasteropods with the chitinous lining ("Trichter") of the gut of Insects and other Arthropods; but it seems doubtful whether he is right in doing this, seeing that while the "Trichter" is confined to the fore and hind gut, the mesenteron ("chylific stomach" of the Insects) is devoid of a cuticular lining and derivative of the hypoblastic midgut. The structures herein described are unlike the cuticular derivatives of the stomodeum and proctodeum, among the Invertebrates, developed internally to the alimentary epithelium, which may itself be converted into a cuticle-like covering where they occur (*ex. sh.*, fig. 7). So far as they may be compared to any known accessories of the alimentary system of other Mollusca, they suggest a kinship to the cartilaginoid supports of the odontophore.

For the material upon which this investigation has been performed I am indebted to the kindness of Mr. M. F. Woodward, and to Prof. G. B. Howes for many valuable suggestions.

\* It may be incidentally remarked that the structure of the plates has a superficial resemblance to masses of coagulated blood in the surrounding organs.

† Haller, *Morph. Jahr.* xviii. p. 502, and *Taf.* 18. figs. 84-86.

‡ Griesbach, *Arch. für mikr. Anat.* xxii. 1883.

§ In the case of the chitin-bearing segment in *Aplysia*, there is wanting proof of its derivation from the stomodeum.



## EXPLANATION OF PLATE XXVIII.

- Fig. 1. *Melongena melongena*, entire animal. Partial dissection from the right side, chiefly to show position of stomach. (Natural size.)
- 2 *a.* Isolated alimentary canal. (Natural size.)
- 2 *b.* Part of œsophagus within proboscis, displayed. (Natural size.)
3. Stomach opened from above, with dorsal wall laid back; showing gastric plates. (Natural size.)
4. Dissection of stomach of another specimen, showing œsophageal plates. ( $\times 3$ .)
5. Longitudinal section of gastric plate. Obj. Zeiss A, Oc. 3.
6. Transverse section of gastric plate. Lenses as for fig. 5.
7. Transverse section of smaller plate. Obj. Zeiss D, Oc. 3.
8. To show leading types of cells in the cuticle of the gastric plates. Lenses combined as in fig. 7.

## REFERENCE LETTERS.

- b.d.* Bile-duct.
- ct.* Cuticular portion of gastric plate.
- ep.* Intestinal epithelium.
- fb.* Fibrous tissue.
- i.* Intestine.
- lc.* Lacunæ or spaces.
- lm.* Lamellæ.
- lv.* Liver.
- m.* Mantle.
- m.c.* Columella muscle.
- œ'.* Œsophagus.
- œ''.* Œsophagus within proboscis.
- op.* Operculum.
- pd.* Foot.
- p.g'.* Dorsal series of gastric plates.
- p.g''.* Ventral series of gastric plates.
- p.œ.* Œsophageal plates.
- r.* Rectum.
- sh.* Sheath.
- st.* Stomach.
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Contributions to our Knowledge of the Arthropod Fauna of the West Indies.—Part I. Scorpiones and Pedipalpi; with a Supplementary Note upon the Freshwater Decapoda of St. Vincent. By R. I. POCKOCK, of the Natural History Museum. (Communicated by W. PERCY SLADEN, Sec. Linn. Soc.)

[Read 16th March, 1893.]

(PLATES XXIX. & XXX.)

THE following report upon the above-mentioned groups of Arthropoda is based upon the material obtained by the collectors in the employ of the Committee for the Exploration of the Fauna and Flora of the Lesser Antilles. But to render the report as complete as possible and of greater use to naturalists resident in the West Indies, descriptions are given of all the species that have been recorded from or that are otherwise known to exist in any of these islands. Trinidad, as being politically one of the West-Indian groups, has been here included, although zoologically this island is but a portion of the mainland of Venezuela.

It is a noticeable fact with regard to the Scorpion fauna of these islands, that whereas the species that are found in Cuba, Hayti, Jamaica, and Porto Rico occur also in Central or South America, those that are found in the Lesser Antilles are apparently peculiar to those islands.

Owing to the unsatisfactory state of our knowledge of the *families* of Scorpions, I have not in this paper adopted any names for groups of this rank. The synoptical table, however, that has been supplied of the *genera* will, it is hoped, remove all difficulties in the way of determining the genus of any species that may require a name.

The species that I have not seen are marked with an asterisk.

## SCORPIONES.

### *Synopsis of the Genera of West-Indian Scorpions.*

- a. The sternum of the cephalothorax laterally compressed, minute and triangular.
- a<sup>1</sup>. The intervals between the large teeth forming the lateral series on the digits of the chelæ not occupied by denticles.

- a*<sup>3</sup>. The individual rows of the median series of teeth on the digits scarcely overlapping ..... ISOMETRUS.
- b*<sup>3</sup>. The individual rows of the median series of teeth overlapping for half their distance ..... TITYUS.
- b*<sup>1</sup>. The intervals between the teeth of the lateral series occupied by longitudinal series of denticles.
  - a*<sup>3</sup>. Pectines only moderately dilated at the base; the first abdominal sternite not sulcate ..... CENTRURUS.
  - b*<sup>3</sup>. Pectines strongly dilated at the base; the first abdominal sternite bisulcate ..... HETEROCTENUS, nov.
- b*. Sternum pentagonal or transversely elongate owing to antero-posterior compression.
  - a*<sup>4</sup>. Sternum pentagonal, distinct and large.
    - a*<sup>5</sup>. With a distinct and large tubercle beneath the aculeus.
      - a*<sup>6</sup>. With three lateral eyes on each side ..... DIPLOCENTRUS.
      - b*<sup>6</sup>. With two lateral eyes on each side ..... OICLUS.
    - b*<sup>5</sup>. Without a tubercle beneath the aculeus.
      - a*<sup>7</sup>. Tail strongly compressed; the anterior border of the carapace strongly excised in the middle; three lateral eyes; sternum as wide as long ..... OPISTHACANTHUS.
      - b*<sup>7</sup>. Tail not compressed; the anterior border of the carapace entire; two lateral eyes on each side; sternum wider than long ..... BROTEOCHACTAS.
  - b*<sup>4</sup>. Sternum transversely elongate, strongly compressed antero-posteriorly.
    - a*<sup>8</sup>. With a large tooth on the lower border of the movable digit of the mandibles; upper surface of the tarsi not carinate ..... HADRURUS.
    - b*<sup>8</sup>. Lower edge of the movable digit of the mandible unarmed; upper edge of the tarsi carinate ..... BRACHISTOSTERNUS, nov.

Genus ISOMETRUS (*Hemp. & Ehrb.*).1. ISOMETRUS MACULATUS (*De Geer*).

This small and slender Scorpion, which is widely distributed throughout the tropical and subtropical countries of the Old and New Worlds, is perhaps the best known species of the Order.

The British Museum has examples from the following West-Indian Islands:—St. Domingo; Jamaica; St. Thomas; St. Croix (*A. Newton*); Barbados (*H. W. Feilden*); Union Island, Grenada (*H. H. Smith*); and Trinidad (*W. E. Broadway*).

Genus TITYUS, *C. Koch*.

*Tityus*, *C. Koch*, *Die Arachn.* iii. p. 33 (1836).

*Isometrus*, *Thorell*, *Etudes Scorpiol.* p. 83 (1876); *Karsch*, *Mitth. Münch. ent. Ver.* p. 18 (1879); *Pocock*, *Proc. Zool. Soc.* 1890, p. 119.

*Phassus*, *Thorell*, *ibid.*; *Kraepelin*, *Jahrb. Hamb. Wissen. Anst.* p. 17 (1891).

*Androcottus*, *Karsch*, *op. cit.* p. 11.

This genus was established by C. Koch in 1836 upon *Scorpio bahiensis* of Perty. This species is clearly therefore the type of the genus, and if such species as *bahiensis* and its allies be considered generically distinct from *Isometrus maculatus*, the name *Tityus* must be retained for them. As I have elsewhere pointed out, I cannot see that Dr. Thorell was justified in selecting the South-African species *lineatus* as the type of *Tityus*, especially as Peters, who was the first to give an intelligible revision of the Scorpions, had previously characterized these South-African forms as his genus *Uroplectes*.

In my revision of the genera of the *Buthidæ*, published in the *Proc. Zool. Soc.* 1890, pp. 114–127, I followed Dr. Thorell and Karsch in considering the species of the *bahiensis* group as congeneric with the *maculatus* group. Prof. Kraepelin, however, has subsequently, and I think rightly, separated the former as a distinct genus, for which he selected Thorell's name *Phassus*. *Tityus*, however, has the priority, and I have consequently restored this old genus of Koch's.

*Synopsis of the Species of Tityus.*

- a.* The inferior keels of some of the caudal segments united ..... *androcottoides*, Karsch.
- b.* The inferior caudal keels not united.
  - a*<sup>1</sup>. A spiniform tooth beneath the aculeus of the vesicle.
    - a*<sup>2</sup>. Less than 50 mm. in length; flavo-maculate ..... *melanostictus*, nov.
    - b*<sup>2</sup>. Adult over 50 mm. in length; not flavo-maculate ..... *americanus* (L.).
  - b*<sup>1</sup>. A small tubercle only beneath the aculeus of the vesicle.
    - a*<sup>3</sup>. Entirely fuscous, of very large size, 23 pectinal teeth ..... *insignis*, Pocock.
    - b*<sup>3</sup>. Flavous, variegated with fuscous, smaller.
      - a*<sup>4</sup>. Caudal keels denticulate, the upper edges of the 5th segment sharp and carinate; pectinal teeth 17.
        - a*<sup>5</sup>. With 12 rows of denticles on the digits of the chelæ, the movable digit short, the hand-back two-thirds of its length ..... *obtusus*, Karsch.
        - b*<sup>5</sup>. With 14 rows of teeth on the movable digit, which is almost three times the length of the hand-back ..... *antillanus*, Thor.
      - b*<sup>4</sup>. Caudal keels granular, the upper edges of the 5th not carinate; pectinal teeth 18-22.
        - a*<sup>6</sup>. Tail slender, the vesicle almost as wide as the 5th segment..... *pictus*, nov.
        - b*<sup>6</sup>. Tail robust, the vesicle much narrower than the 5th segment ... *Smithii*, nov.

2. TITYUS ANDROCOTTOIDES (*Karsch*). (Pl. XXIX. figs. 3-3 b.)

*Isometrus americanus*, var. *androcottoides*, *Karsch*, *Mitth. Münch. ent. Ver.* 1879, p. 113.

*Isometrus androcottoides*, *Pocock*, *Ann. Mag. N. Hist.* (6) iv. p. 57.

The British Museum has received very many examples of this species from Trinidad (*Messrs. Hart and Broadway*). It is common in British Guiana (*Brit. Mus., W. L. Slater*).

Although Dr. Karsch looked upon this Scorpion merely as a variety of *T. americanus*—an opinion in which he has been followed by Prof. Kraepelin—I think there can be little doubt of its distinctness. When first I put forward this suggestion, I had only seen a few examples of the form to which the name *androcottoides* would apply; but during the past three years the British Museum has received many others, all of which justify the belief in the distinctness of *androcottoides* from *americanus*.

Apart from sexual characters which are very distinctive, this species may be recognized from *americanus*, as from all the Antillean species of the genus, by the fusion of the inferior keels of the posterior caudal segments.

### 3. TITYUS AMERICANUS (Linn.). (Pl. XXIX. figs. 2, 2 b.)

*Scorpio americanus*, Linn. *Mus. Adolph. Frid.* p. 84 (1754).

*Scorpio europæus*, Linn. *Syst. Nat.* ed. 10, p. 625 (1758); *De Geer*, *Mém.* vii. p. 344, pl. xli. figs. 5–8, ♀.

*Scorpio obscurus*, Gervais, *Arch. Mus.* iv. p. 219, ♀.

*Scorpio forcipula*, *id. loc. cit.* p. 221, pl. xi. fig. 26, ♂.

*Isometrus americanus*, Thorell, *Etudes Scorpiologiques in Atti Soc. Ital.* xix. p. 90; Bertkau, *Mém. Ac. Belg.* xliii. p. 7; Karsch, *Mitth. Münch. ent. Ver.* 1879, p. 113; Pocock, *Ann. Nat. Hist.* (6) iv. 1889, p. 57.

*Phassus americanus*, Kraepelin, *Jahrb. Hamb. Wissen. Anstalten*, viii. p. 112 (1891) (at least in part.)

This species, which is widely distributed throughout the northern parts of South America, occurs in Hayti and Porto Rico (*teste* Kraepelin and *Mus. Brit.*).

*Note.*—At present, in spite of the opinions of some of my contemporaries, I decline to admit the species named *T. æthiops* and *T. longimanus* of C. Koch (*Die Arachn.* xi. pp. 856–857) amongst the synonyms of *T. americanus*. My reasons are briefly these:—(1) C. Koch records the specimens of these species from Java, where *T. americanus* can only accidentally occur; (2) these two so-called species are clearly to me sexes of one and the same form, which must be called *æthiops*, and their sexual characters are not those of *T. americanus*.

4. *TITYUS INSIGNIS* (*Pocock*). (Pl. XXIX. figs. 1-1 a.)

*Isometrus insignis*, *Pocock, Ann. Nat. Hist.* (6) iv. p. 57 (1889).

*Locality.* Fond de Jacques in St. Lucia, collected by G. A. Ramage, Esq.

This species is the largest of the genus, since it attains a length of 110 mm. It is closely allied to *T. americanus*, but may be at once recognized by the presence of only a minute tubercle beneath the aculeus; the aculeus, too, is only lightly curved as compared with that of *T. americanus*. The male is unknown.

5. *TITYUS OBTUSUS* (*Karsch*). (Pl. XXX. figs. 10-10 a.)

*Isometrus obtusus*, *Karsch, Mitth. Münch. ent. Ver.* 1879, p. 117, ♀.

? *Isometrus antillanus*, *Thorell, Etudes Scorpiol.* p. 60, ♀ (cf. *infra*).

♂. *Colour* (dry) ochraceous, variegated with black. Cephalothorax ochraceous, the anteocular area and tubercle fuscous, the fuscous patch with a flavous spot just in front of the tubercle, the posterior keels also fuscous, with a fuscous spot on the posterior margin outside the keel; tergites ochraceous, very indistinctly fusco-maculate; the lower surface of the trunk ochraceous, concolorous; tail with its anterior three segments uniformly ochraceous above, variegated with fuscous below, the fuscous colouring increasing posteriorly, the fourth and fifth segments and vesicle brunneo-fuscous above and below, deeper below; aculeus ferruginous, with black tip; palpi fusco-maculate above, the manus distinctly fusco-variegated externally, digits black, with ferruginous tips; legs with femora and tibiæ fusco-maculate; tarsi pale.

*Trunk* above granular; the anteocular and posterior keels of the carapace coarsely granular, the median keel of the tergites feebly granular; fourth and fifth *sternites* finely granular; keels of the latter conspicuous and more coarsely granular.

*Tail* more than six times the length of the carapace, expanding from the base to the middle of the fifth segment; the upper surface of the segments somewhat deeply excavated, the first with 10 keels, the second to the fourth with 8, the median lateral of the second complete only posteriorly, all the keels well expressed and coarsely granular, the superior especially strong and denticulate; the intercarinal spaces at the base of the tail nearly smooth, but becoming gradually more and more granular towards the posterior end; the granules of the upper surface of the

fourth subserially arranged, the sides and lower surface of the fourth and fifth coarsely and closely granular throughout, the upper surface of the fifth also granular, smooth only in the middle and at its anterior end; vesicle granular laterally and below, distinctly denticulate on each side in front; a distinct tubercle beneath the aculeus. Upper surface of palpi normally granular and costate; *manus* large, wide and long, finely granular above, with granular costæ, its width about half the length of the movable digit, the length of the hand-back about two-thirds the length of this digit; digits sinuate at the base, lobate internally, and not in contact when closed, with about 12 rows of denticles.

*Pectines* with 17 teeth.

Length 60 mm.; length of carapace 6·3, of tail 41, width of 1st segment 3·2, of 5th 4, of vesicle 3, length of 1st 5·5, of 5th 7·5; length of brachium 7, width 2·2; length of "hand-back" 5, width of hand 3·5, length of movable digit 7·5.

*Locality.* San Domingo (*Mus. Brit.*); Porto Rico (*Mus. Berol.*).

The above description is taken from a single male example from San Domingo, in the collection of the British Museum. The female is unknown to me, but Dr. Karsch's description of examples of this sex in the Berlin Museum from Porto Rico, although unsatisfactory in many points, seems to apply to individuals which differ from the one from San Domingo in characters which by analogy are merely of sexual importance. Thus in the female the *manus* is not wider than the brachium, with the movable digit only slightly lobate; the *pectines* are basally lobate, and the tail is shorter, its fifth segment being only equal to the carapace in length. Moreover, Dr. Karsch makes no mention of the gradual expansion of tail from the base to the fifth segment.

It may thus be seen that the sexual features of *T. obtusus* are practically the same as those of *T. americanus*. Nevertheless Prof. Kraepelin undoubtedly fell into error in believing the two species to be synonymous. Apart from the marked difference between them in size and colouring, *T. americanus* being considerably larger and of a nearly uniform dark tint, the latter species has a large spiniform tooth beneath the aculeus of the caudal vesicle, and the intercarinal spaces of the tail not closely and coarsely granular.



6. *TITYUS MELANOSTICTUS*, sp. n. (Pl. XXIX. figs. 4-4b.)

*Colour* flavous or fulvous, fusco-maculate, the ocular tubercle and anteocular portion of carapace fuscous, mesially flavous, the posterior and lateral portions of this plate fusco-maculate and lineate; each of the tergites, except the last, furnished in front with a transverse row of fine fuscous spots, the external spot on each side is situated on the very margin of the plates, the median one is divided by a flavous spot marking the median keel; posteriorly the tergites are adorned with three fuscous spots, the median of which is divided, like the spot in front of it, by a clear flavous spot, and the two lateral ones are united by a fine fuscous line, which marks the transverse granular ridge; the last abdominal segment, above and below, fusco-maculate; the rest of the sternites concolorous; the upper surface of the tail mostly concolorous, sometimes obscurely fusco-maculate, the lower surface of the first three segments mottled with flavous, the fourth and fifth segments and the vesicle generally uniformly infusate or reddish brown; palpi subfuscous, mottled with round clear flavous spots above, the digits fuscous at the base, becoming gradually pale distally; legs externally fusco-maculate.

♀. The *upper surface* of the body subtly granular, the normal keels not strong but visible; the *sterna*, except the last, smooth, marked with more or fewer large punctures; the last subtly granular with black keels. The *tail* about  $5\frac{1}{2}$  times as long as the carapace, subtly granular, the keels visible but weak and subtly granular; the first segment with ten keels, the second with eight and a trace of the median lateral; the first segment a little wider than the fifth. The vesicle armed with an acute conical tooth beneath the aculeus.

The *palpi* with well-expressed granular keels, the intercarinal spaces coriaceous; the manus small, internally rounded and produced, normally costate, the costæ scarcely distinctly granular; its width considerably less than half the length of the movable digit and less than the width of the brachium. The *digits* long and slender, contiguous, neither lobate nor sinuate; the movable digit about twice the length of the "hand-back," and furnished with 14 rows of teeth.

The *pectines* shorter than the posterior coxæ, furnished with 15-17 (usually 16) teeth; the proximal lamella of the intermediate series produced internally into a rounded prominence.

♂. *Tail* parallel-sided, the fifth segment being equal to the first in width and a little more deeply excavated above, considerably smoother than in the female; the keels almost obsolete, about 6 times as long as the cephalothorax. The *manus* larger than in the female, the width about equal to half the length of the movable digit and much greater than the width of the brachium; the movable digit sinuate at the base with a distinct lobe, less than twice the length of the "hand-back;" the immovable also sinuate, so that when closed the two are separated at the base.

*Pectines* longer than in the female, just reaching the end of the 4th coxæ; the teeth longer than in the female, 17 in number.

Length of female 47 mm., of carapace 5, of tail 28, width of 1st segment 2·8, length of 5th 5·2, width of 5th segment 2·5, of vesicle 1·8; length of "hand-back" 2·7, of movable digit 6.

Length of male 43 mm., of carapace 4·3, of tail 26, width of tail 2·5, of vesicle 1·5, length of vesicle 1·8.

*Locality.* Trinidad.

This pretty little species seems to be tolerably common in Trinidad. The British Museum has received examples from Messrs. W. E. Broadway, J. H. Hart, R. L. Guppy, and Lady Broome.

#### 7. *TITYUS PICTUS*, sp. n. (Pl. XXX. figs. 8-8 a.)

*Colour* very like that of *T. melanostictus*, but with the fuscous patches larger and imparting a darker aspect to the whole animal, the antecular fuscous patch generally entire, the 4th and 5th segments of the tail and the vesicle more deeply fuscous, and the dactyli entirely fuscous except their tips.

♀. The trunk more coarsely granular than in *T. melanostictus*, the keels better marked. *Tail* slender, rather more than  $5\frac{1}{2}$  times the length of the carapace, the 1st segment a little wider than the 5th; all the segments more parallel than in *T. melanostictus*, the keels higher and more conspicuously granular; the vesicle much more robust than in *T. melanostictus*, with only a small tubercle beneath the aculeus. *Manus* of the palpi conspicuously keeled above, larger than in *T. melanostictus*, the width less than half the length of the movable digit; digits long and slender, the movable scarcely more than twice the length of the "hand-back," with 13 rows of teeth; the two digits contiguous, although lobate and sinuate proximally.

*Pectines* not reaching the end of the coxæ, furnished with 19–20 teeth; the proximal intermediate lamella dilated.

♂. *Tail* very long, about  $7\frac{1}{2}$  times the length of the carapace, the fifth segment very slightly wider than the first; the “manus” larger than in ♀, a little longer and wider; the length of the “hand-back” about  $\frac{2}{3}$  the length of the movable digit; the lobe and excavation a little bigger than in the ♀, but the digits not noticeably sinuate as in *T. antillanus*.

*Pectines* nearly reaching the end of the coxæ, furnished with 21–22 teeth; the proximal intermediate lamella not expanded.

Length of ♀ 56 mm., of carapace 6, of tail 35; length of ♂ 63, of carapace 5.5, of tail 41.

*Locality.* St. Vincent (*H. H. Smith*).

8. *TITYUS SMITHII*, sp. n. (Pl. XXX. figs. 9–9 a.)

Nearly allied to *T. pictus*. The two species may be contrasted as follows:—

<i>T. pictus.</i>		<i>T. Smithii.</i>	
	mm.		mm.
♂. Total length.....	63.5	♂. Total length .....	62.5
Length of carapace.....	5.5	Length of carapace .....	5.8
"    tail.....	40.5	"    tail .....	40.5
Width of 1st caudal segm....	2.4	Width of 1st caudal segm. ...	3.2
"    5th "    "    ....	2.5	"    5th "    "    ....	3.5
"    poison-vesicle .....	2.2	"    poison-vesicle .....	2
Height of "    "    "    ....	2.3	Height of "    "    "    ....	2
Length of vesicle.....	4	Length of vesicle .....	3.5
"    aculeus .....	2.9	"    aculeus.....	3.2
♀. Total length.....	54	♀. Total length .....	59
Length of carapace .....	5.8	Length of carapace .....	5.3
"    tail .....	35	"    tail .....	35.5
Width of 1st caudal segm....	2.5	Width of 1st caudal segm. ...	3.2
"    5th "    "    ....	2.3	"    5th "    "    ....	3.8
"    poison-vesicle .....	2.1	"    poison-vesicle .....	2

The above dimensions show at a glance the chief differential characters of *T. Smithii*. The tail is much stouter, while the vesicle is much smaller, being narrower, lower, shorter, and furnished with a longer aculeus. In colouring the two species are almost alike; but on the whole the fuscous markings of *T. pictus* are more conspicuous, the general aspect of the whole animal being more mottled. In development of keels and granulation there is no observable difference between the two; the hands, however, of *T. pictus* are a little slenderer.

The specimens of which the measurements are given in the above Table were selected because they agreed best with the largest examples of *T. pictus*. The apparent discrepancy in the

length of the two females is due to the fact that the trunk of the female of *T. pictus* is very much shrunken. The largest female of *T. Smithii* measures 63 mm. in length, the carapace being 6.5.

The pectinal teeth are the same as in *T. pictus*, varying from 18-21 in the female, and from 20-21 in the male.

Of this species I have seen three males and three females from Grenada, collected by R. V. Sherring, Esq.; and two males and two females from the Grenadines (Mustique and Bequia) obtained by H. H. Smith, Esq.

The examples from Mustique and Bequia differ from the others in having the tooth beneath the aculeus noticeably smaller, being merely a minute tubercle scarcely observable by the naked eye. Another difference, to which, however, analogy forbids one to attach much importance, is the greater width of the hand. Thus in a specimen from Grenada having the *brachium* 2.5 mm. in width, which is the same as in the male from Mustique Island, the *manus* is only just over 3 mm., while in the male from Mustique Island the *manus* is 4 mm. Curiously enough, too, in both the specimens from Mustique Island the movable digit has its distal third ferruginous, while in the Grenada form the digit is ferruginous only at the apex.

Since these characters also obtain in the specimens from Bequia, I propose to regard these Grenadine examples as representatives of a variety which may be called *microdon*.

#### 9. \**TITYUS ANTILLANUS* (Thorell).

*Isometrus antillanus*, Thorell, *Etudes Scorp. Iol.* pp. 60-62.

This species, described from a single female example from the Antilles, is unknown to me.

Prof. Kraepelin suggested that it might be one of the synonyms of *T. americanus*. It is, however, not *T. americanus* as recognized by me.

In colouring it approaches *T. obtusus*, *T. pictus*, and *T. Smithii*, being testaceous and marbled with black; it differs from them all, however, in having the vesicle flavous.

The carapace is subtly granular, but more coarsely anteriorly; the tergites, too, are subtly granular; the sternites are very subtly coriaceous.

*Tail* very nearly six times the length of the carapace, parallel-sided, the width of the first segment and fifth being equal; the keels are denticulate, and the superior lateral keels of the fifth are acute and bluntly denticulate; the intercarinal spaces

of the posterior segments are densely and coarsely granular; the *vesicle* ovate, sparsely granular, almost as wide as the fifth segment (2·5 mm. : 3), with a small thick tooth beneath the long aculeus.

*Palpi* with hands equal in width to the brachium; the movable digit a little less than twice the length of the hand-back, scarcely lobate, with 14 rows of teeth.

*Pectines* with 17 teeth.

Total length 53 mm., of carapace 5·7, of tail 34, width of tail 3, length of fifth segment 6·2.

Of the preceding species *T. antillanus*, in having the tail posteriorly coarsely and closely granular, its keels denticulate, and the superior lateral margins of the fifth segment sharp, approaches apparently most nearly to *T. obtusus* of Karsch, which it further resembles in having a wide caudal vesicle, a small tooth beneath the aculeus, and the same number of pectinal teeth. But never having seen the female of *T. obtusus*, I do not feel justified in making the two synonymous.

#### Genus CENTRURUS (*Hempr. & Ehrb.*), *Thorell.*

##### *Synopsis of the Species of Centrurus.*

- a.* The 2nd and 3rd caudal segments furnished with 10 keels ..... *princeps*, Karsch:
- b.* The 2nd and 3rd caudal segments furnished with only 8 keels.
  - a*<sup>1</sup>. A distinct spine beneath the aculeus of the poison-vesicle; the pectinal teeth on an average 30 (25-35).
  - a*<sup>2</sup>. With 9 rows of teeth on the digit of the palp; hand thinner, granulation finer, colour darker ..... *gracilis* (Latr.).
  - b*<sup>2</sup>. With 8 rows of teeth on the digit of the palp; hand thicker, granulation coarser, colour redder ..... *margaritatus* [(Gerv.).
  - b*<sup>1</sup>. With only a minute tubercle beneath the aculeus of the vesicle; pectinal teeth fewer than 25.
    - a*<sup>3</sup>. Hand wider, its width in the adult more than half the length of the movable digit; tail smoother, shining ..... *nitidus*, Thor.
    - b*<sup>3</sup>. Hand narrower, its width about one third the length of the movable digit.
      - a*<sup>4</sup>. Tail much thinner; trunk a uniform tint above and more coarsely granular ..... *testaceus* (De Geer).

- b*<sup>4</sup>. Tail stouter; the trunk more finely granular, fuscous above, the tergites adorned with three yellow spots ..... *insulanus*, Thor.

#### 10. CENTRURUS GRACILIS (*Latr.*).

*Scorpio australis*, *De Geer, Mém. etc.* vii. p. 348, *teste Thorell*; not *australis* of Linn.

*Scorpio gracilis*, *Latr. Hist. Nat. Gén. Crust. et Ins.* vii. p. 127 (1804).

*Androctonus biaculeatus*, *Lucas in Webb & Berthelot's Hist. Nat. Canaries*, ii. pt. 3, p. 45; *Gervais, Ins. Apt.* iii. p. 54, pl. 23. fig. 3; *id. in Castelnau, Expéd. dans l'Amér. Sud, Scorpiones*, pl. ii. fig. 4.

*Centrurus heterurus*, *Karsch, Mith. Münch. ent. Ver.* 1879, p. 122 (at least in part).

This species is one of the commonest North Neotropical forms, being widely distributed in Central America and at least the northern parts of South America. It does not, however, appear to be common in the West Indies, since the British Museum has only one specimen from this region, and that is merely ticketed vaguely "Antilles."

The colour is usually a deep blackish green tinged with ferruginous, the legs and hands being especially liable to take on a clearer reddish colour.

The trunk is coarsely granular above. The tail is slender, posteriorly slenderer, about six times the length of the carapace in the female, and more than nine times in the male, there is a long spine close to the base of the aculeus. The palpi are slender, the manus being only a little wider than the brachium; the superior keel of the manus is strong, as a rule, and there are 9 rows of denticles on the digit. The pectines are furnished with an average of about 30 teeth (25-35).

#### 11. CENTRURUS MARGARITATUS (*Gervais*).

*Scorpio margaritatus*, *Gervais, Voyage de la Bonite*, i. p. 281, *Atlas, Apt.* pl. i. figs. 13-17 (Paris, 1841); *id. Ins. Apt.* viii. p. 55 (1844).

*Atræus Edwardsii*, *Gervais, Arch. Mus.* iv. p. 216, pl. xi. figs. 13, 14 (1844); *id. Ins. Apt.* iii. p. 53; *id. in Castelnau, Expéd. dans l'Amér. Sud, Scorpiones*, pl. i. fig. 1.

*Atræus De Geerii*, *Gervais, Arch. Mus.* iv. p. 217, pl. xi. figs. 16, 17; *Ins. Apt.* iv. p. 54.

This species is common in Central America, Colombia, &c. It is evidently abundant in some parts of Jamaica, whence the British Museum has received many examples from Mr. Cockerell

and Mr. Peckham. We have no specimens, however, from any other West-Indian island.

There has been much unnecessary difficulty about the identity of this form, partly owing to confusion between it and the preceding species, *C. gracilis*. The two are in reality very easy to distinguish by the eye; but I believe the credit of first setting down their differential characters in tabular form belongs to Prof. Kraepelin. Strangely enough, however, this author seems to me to have gone hopelessly wrong about the names of the two; for he regards *Edwardsii* of Gervais as a synonym of *gracilis* (Latr.) (*biaculeatus*, Luc.), and what I have called *margaritatus* he terms *De Geerii*. But it seems clear to me that *De Geerii* is the same species as *Edwardsii*, although a different sex, and that both are synonymous with *margaritatus*. I strongly suspect that Prof. Kraepelin's mistakes are attributable to his ignorance of Gervais's original figures of *Edwardsii*, *margaritatus*, and *biaculeatus*. That Dr. Thorell failed to identify *margaritatus* is probably because Gervais's figure indicates that the crests upon the hands are granular. But this is probably pure imagination on the part of the artist, for the description merely says "*dessus de la main côtelé.*" Moreover, if *margaritatus* is to be excluded on account of its figure, so also must *Edwardsii*; for the artist has made the same exaggeration in the figure of the last-named species. Prof. Kraepelin, it seems likely, has been thrown off the scent with regard to *margaritatus* through not consulting Gervais's original description; for it is there asserted that the locality for the species is the Isle of Puna in the Gulf or River of Guayaquil, exactly one of the spots where the species might be expected to occur\*. Gervais's statement in the 'Ins. Apt.' vol. iii., that the Island of Puna is in the Straits of Malacca is of course a mistake.

This species may be recognized from *C. gracilis* by being more coarsely granular, by having wider, more strongly crested hands, with shorter digits and fewer rows of teeth upon them. Moreover, as a very general, although not invariable, rule, the hands are darker than the rest of the palpi, and the digits are largely flavous, as also are the legs and the intercarinal spaces of the tail. In *gracilis* usually the hands are paler than the rest of the palpi, the digits fuscous, the whole animal being of a darker tint than *C. margaritatus*.

\* I have seen examples of this species from Guayaquil, whence they were brought by Mr. Edward Whyper.

12. *CENTRURUS INSULANUS*, *Thorell*. (Pl. XXX. figs. 12-12 b.)

*Centrurus insulanus*, *Thorell*, *op. cit.* p. 148; *Kraepelin*, *op. cit.* p. 127.

*Colour* pale fuscous above, the tergites adorned with three yellow bands, one median and one on each side; the upper surface of the tail and the lower surface of the trunk and appendages pale, but the lower surface of the tail and the external surface of the legs infusate; palpi infusate above, the manus pale internally; digits infusate, with flavous tips.

♀. *Trunk* closely but not strongly granular above; smooth beneath and punctured, the third sternite being especially coarsely punctured in the middle of the hinder half. *Tail* about  $5\frac{1}{2}$  times the length of the carapace, slightly narrowed posteriorly; the keels finely granular, the inferior ones stronger than the superior, the first four segments not twice as long as wide, the fifth just about twice as long as wide, its superior edges rounded; the intercarinal spaces very finely granular; *vesicle* ovate, with a minute tubercle beneath the aculeus but at some distance from its base.

*Palpi* moderate; manus a little wider than the brachium; the length of the "hand-back" more than half the length of the movable digit, the middle series of denticles on the digits consisting of 8 rows.

*Pectines* short, containing about 20 teeth.

Length 66 mm., of carapace 6·3, of tail 37; width of 1st segment 3·3, length 4·2; width of 5th 3, length 7.

*Adult* ♂. Longer and slenderer than female; the tail about  $6\frac{1}{2}$  times the length of the carapace and parallel-sided, the segments, with the exception of the 1st, more than twice as long as wide.

*Palpi* slightly longer than in the female.

Length 71·5 mm., of carapace 7, of tail 47·5.

*Locality*. Jamaica; also, according to specimens in the British Museum, from Choco and Brazil.

The Museum has received many examples of this species from Mr. G. W. Peckham and Mr. T. D. A. Cockerell.

This species may be at once recognized from the preceding two by its finer granulation, difference in colour, absence of a spine beneath the aculeus, smaller number of pectinal teeth, &c.



13. *CENTRURUS TESTACEUS* (*De Geer*). (Pl. XXX. figs. 11–11 a.)

*Scorpio testaceus*, *De Geer*, *Mém.* vii. p. 347, pl. 41. fig. 11.

*Centrurus testaceus*, *Thorell*, *op. cit.* p. 160 ; *Kraepelin*, *op. cit.* p. 130.

♀. Colour a uniform testaceous or pale ochraceous throughout, the digits alone and the apex of the aculeus being lightly fuscous ; eyes black.

*Trunk* somewhat coarsely granular above ; anterior *sternites* of the abdomen shining, sparsely punctured, the 3rd not thickly punctured, the 4th coriaceous and subcostate, the 5th very finely granular, the keels well developed. *Tail* slender, slightly attenuated posteriorly, about six times the length of the carapace, the second segment twice as long as wide, all the intercarinal spaces finely granular, the keels well expressed and granular, the upper edges of the fifth not carinate ; the vesicle almost the same shape as in *C. insulanus*, but the aculeus sloped more backwards and the tubercle closer to its base. *Palpi* almost exactly as in *C. insulanus*, but perhaps rather longer, and with the keels on the manus a little more strongly expressed ; with 8 or 9 rows of denticles along the median series.

*Pectines* short, with about 20 teeth.

♂. Slenderer than female ; tail slightly attenuated posteriorly, about eight times the length of the carapace, the second segment about three times as long as wide, the vesicle elongate and ovate ; manus a little wider and distinctly longer than in the female. *Pectines* longer, with about 23 teeth.

Measurements in millimetres :—

♀. Total length 63, of carapace 6·3, of tail 37·5 ; width of 1st segment 2·8, length 4·8 ; width of 5th 2·5, length 7.

♂. Total length 64, of carapace 5·5, of tail 44 ; length of 1st segment 5, width 2·3 ; length of 2nd 6·6, width 2·2 ; length of 5th 8·8, width 2·2.

*Locality*. Montserrat (West Indies) ; presented by Sir A. Alderley.

This species has hitherto been known only from the West Indies ; this is, I believe, the first occasion on which a definite locality has been assigned to it.

This species resembles *C. insulanus* in possessing only a minute tubercle beneath the aculeus, and in having only about 20 pectinal teeth ; it is, however, more coarsely granular, differently coloured, has a much slenderer tail (*cf.* measurements), a differently formed vesicle, &c.

14. *CENTRURUS NITIDUS*, *Thorell*. (Pl. XXIX. figs. 5-5 b.)*Centrurus nitidus*, *Thorell*, *op. cit.* p. 152; *Kraepelin*, *op. cit.* p. 129.*Centrurus tenuis*, *Thorell*, *op. cit.* p. 153.*Centrurus republicanus*, *Karsch*, *op. cit.* p. 120.

*Colour* testaceous, carapace anteriorly infusate, a fuscous patch upon each side of the tergites; tail inferiorly infusate towards its distal end; digits fuscous, with pale tips.

♀. *Trunk* above granular, but not closely or coarsely, the posterior keels of the carapace low. *Tail* parallel-sided, about six times the length of the carapace, shining; the intercarinal spaces, except posteriorly on the inferior surface, smooth; the keels granular, except those on the lower surface of the 1st segment, which are almost smooth; the superior edges of the 5th rounded, this segment about twice as long as wide, much wider than the brachium, almost as wide as the hand; *vesicle* smooth, with a minute tubercle close to the base of the aculeus. *Palpi* moderate; hands wide, much wider than the brachium, obsoletely costate above; the digits short, the back of the hand a little more than two thirds their length.

*Pectines* short, furnished with 17 teeth.

♂. *Tail* from  $7\frac{1}{2}$  to 8 times the length of the carapace, generally slightly expanded towards its distal end, in one specimen parallel-sided; the 5th segment usually about two and a half times as long as wide (in one example more than three times as long as wide), usually considerably wider than the brachium.

Measurements in millimetres:—

♀. Total length 51, of carapace 5, of tail 31; length of 5th segment 5·8, width almost 3; width of brachium 2, of manus just over 3; length of "hand-back" almost 4, of movable digit 5·2.

♂ *a* (largest). Total length 69, of carapace 6, of tail 49; width of 1st segment 3, of 5th 3·3, length of latter 8·6; width of brachium 2·5, of manus 3·5; length of hand-back 5, of movable digit 6·5.

♂ *b*. (smaller). Total length 61, of carapace 5, of tail 40; width of 1st and 5th segments 2·3, length of latter almost 8; width of brachium 2, of manus 2·5.

*Locality*. Hayti, whence the British Museum has specimens. It also occurs in Brazil.

Of the above examples one only is a female. This and three of the males agree closely with *Thorell's* description of *C. nitidus*; the other male, the one from *Keyserling's* collection, is inter-

mediate in character between Thorell's *nitidus* and his *tenuis*: consequently I do not hesitate to adopt the above synonymy, which Prof. Kraepelin was the first to establish.

This species agrees tolerably closely in most of its characters with *C. testaceus* and *C. insulanus*; it may, however, be at once recognized by its thicker hands and relatively shorter fingers.

15. \*CENTRURUS PRINCEPS, *Karsch, op. cit.* p. 121; *Kraepelin, op. cit.* p. 139.

*Locality.* Port au Prince (Hayti).

This species is very likely referable to the following genus, *Heteroctenus*, to both of the known species of which it offers a great likeness.

It may be recognized from all the other known West-Indian species of *Centrurus* in having the median lateral keel complete on the 2nd and 3rd segments.

The following two are of doubtful position both generically and specifically:—

\*TITYUS GRISEUS, *C. Koch, Die Arachniden*, xi. pp. 43–45.

This species, described from St. Thomas, may be either a *Centrurus* or a true *Tityus*. There is no apparent reason for supposing that it is *Scorpio griseus* of Fabricius.

\*SCORPIO GRISEUS, *Fabr. Ent. Syst.* ii. p. 435, no. 7.

“*S. pectinibus vigintiquinque dentatis, manibus subciliatis ovatis.*”

“*Habitat in Americæ Insulis.*”

“*Corpus parvum, pallide testaceum, immaculatum. Manus subciliatæ, chelis ovatis, digitis fuscis. Cauda corporis longitudine, 6-articulata, ungue acutissimo.*”

HETEROCTENUS, gen. nov.

(ἑτερος, different; κρεῖς, κρεῖος, a comb.)

Resembles *Centrurus* (Ehrb.) in most respects.

*Pectines*, in both sexes, expanded at their proximal extremity owing to an increase in width of the intermediate lamellæ of the basal half of the organ. The sternal plate that supports the pectines large, with ovate posterior border. The following sternum that bears the first pair of stigmata marked on each side with a strong groove which rises from the inner end of the

stigma and passes obliquely inwards for half its length, then almost directly forwards to meet its fellow of the opposite side at the anterior edge of the sternum. The poison-vesicle without or with a spine beneath the sting.

In *Centrurus* the pectines are only gradually attenuate from the base to the apex; the sternum that supports them is an inconspicuous plate smaller than the genital operculum, and the sternum of the first somite that bears the stigmata is only furnished with two shallow depressions. Beneath the aculeus there is a spine or tubercle.

#### 16. HETEROCTENUS JUNCEUS (*Herbst*).

*Scorpio junceus*, *Herbst*, *Nat. ungeflügelt. Insekten*, iv. p. 65, pl. 3. fig. 2.

*Scorpio Hemprichii*, *Gervais*, *Ins. Apt.* iii. p. 54; *id.* *Arch. Mus. Hist. Nat.* iv. p. 218, pl. xi. fig. 18; *id.* in *Castelnau*, *Expéd. dans l'Amér. du Sud*, vii. *Zool.* iii. p. 41, pl. i. fig. 2.

*Rhopalurus Hemprichii*, *Karsch*, *Mitth. Münch. ent. Ver.* 1879, p. 119.

*Centrurus Hemprichii*, *Kraepelin*, *Jahrb. Hamb. Wiss. Anst.* viii. p. 135.

♀. *Colour* ochraceous or castaneous; aculeus and digits fuscous, with fulvous tips; tail posteriorly infusate. *Carapace* coarsely and subserially granular. *Abdomen* also coarsely granular above, smooth but punctured beneath. *Tail* rather more than  $5\frac{1}{2}$  times the length of the carapace, gradually expanded from the base to the middle of the 4th segment; the 5th in the middle almost as wide as the 4th, abruptly narrowed posteriorly; all the keels well developed, granular, the superior ones, except on the 5th segment, denticulate; the 1st segment with 10 keels, the 2nd, 3rd, and 4th with 8. *Vesicle* ovate, aculeus long. *Palpi* powerful; manus rounded, considerably wider than the brachium, obsoletely keeled; digits long, in contact, the movable about twice as long as the hand-back. *Pectines* short, with from 17–19 teeth.

Total length 105 mm., of carapace 12, of tail 65; width of 1st tail-segment 6·5, of 4th 7·5, of brachium 4·5, of manus 6; length of hand-back 7, of movable digit 14.

♂. Tail slightly longer than in female, being nearly six times the length of the carapace, and much more robust, expanded from the base to the middle of the 5th segment. Manus much wider than in the female; the digits strongly sinuate, and widely separated at the base. *Pectines* with from 18–23 teeth.

Total length 97 mm., of carapace 11, of tail 65.5; width of 1st segment 7, of 5th 9, of brachium 4, of manus 7.

*Locality.* Hayti (*Mus. Brit. etc.*).

According to other specimens in the British Museum collection, this species also exists in Mexico and Brazil.

Hitherto this form has been known by the specific name of *Hemprichii*. But *Sc. junceus* of Herbst appears to me to be the same Scorpion, and I have consequently adopted this name for it. Herbst's specimen was said to have only 16 pectinal teeth, a number which is somewhat below the average; but it does not seem that this character can be of any great value, seeing that within the limits of the eleven specimens known to me the number varies from 17-23.

In addition to the species recorded above, I refer to this genus a second, of which the British Museum possesses three specimens from Brazil. These specimens I, without hesitation, identify as *H. Agamemnon*, C. Koch (*Die Arachn.* vi. p. 103, fig. 506). *H. Agamemnon* differs from *H. junceus* in having an acute spine beneath the aculeus of the tail and in having the subpectinal area of the first sternite finely granular, &c.

Possibly also *Centrurus princeps* of Karsch is a *Heteroctenus* (*cf. supra*).

Genus DIPLOCENTRUS, *Peters, Mon. Ak. Wiss. Berlin*, 1861, p. 512; *Thorell, Etudes Scorp. p. 10.*

*Anterior* border of carapace deeply excised in the middle; the ocular tubercle cleft and situated well in advance of the middle of the plate. Three lateral eyes on each side, almost on the very edge.

*Tail* moderately strong; vesicle with a distinct tooth beneath the aculeus, which is very short.

*Palpi* robust; hands large, convex, the denticles of the digits consisting of a close-set median series, on each side of which is a lateral series consisting of more scattered denticles, some of which are enlarged.

*Chelicerae* with the superior terminal fang much shorter than the inferior.

Terminal tarsal segment of the *legs* armed beneath with two parallel rows of spines.

*Sternum* pentagonal, about as wide as long, with parallel sides.

*Genital operculum* cleft in the male, its halves united in the female.

*Pectines* of normal construction.

*Stigmata* elongate.

17. \**DIPLOCENTRUS GUNDLACHII*, *Karsch, Zeits. Naturwissen.* (3) v. pp. 407-408 (1880).

This species has been very briefly described.

The upper surface of the trunk is entirely smooth. The dorsal surface of the head is evenly arched, and nearly smooth. The first four segments of the tail have 10 complete keels.

Pectinal teeth 6-8.

Length 30-32 millim.

*Locality.* Trinidad and Cuba.

18. *DIPLOCENTRUS ANTILLANUS*, sp. n. (Pl. XXIX. figs. 6-6a.)

♀. *Colour* fusco-castaneous above; legs and vesicle ferruginous, lower surface of trunk ochraceous; rarely (in smaller specimens) the upper surface is paler and obscurely variegated with fuscous. Smooth and polished.

*Carapace* smooth, very finely and closely punctulate, at most obsoletely granular at the sides; the tubercle small, undivided, the area in front and behind it deeply sulcate longitudinally; the anterior border deeply emarginate in the middle, the frontal lobes rounded.

*Tergites* smooth, finely punctulate, minutely granular only posteriorly; the last, however, more coarsely granular at the sides, some of the granules on each side arranged in two series, so that the tergite may be said to be furnished with four keels.

*Sternites* smooth, finely punctulate, and studded with a few larger punctures, two of which are symmetrically placed near the middle on each side of the central line; a distinct longitudinal depression on the inner side of each of the stigmata; the last sternite more distinctly punctulate and obsoletely quadricostate posteriorly.

*Tail* about four times the length of the carapace, which is a little shorter than the first two segments, tolerably deeply and widely excavated above, finely punctulate; the keels all well-developed but not granular, at most crenulate, but impressed with setiferous pores which give them a roughened appearance; the first and second segments furnished with 10 keels; the median lateral keel, however, of the second weaker than the

others, the third segment with 8 keels and a trace of the median lateral; the superior lateral keel of the first four segments strong in front and terminating in a rounded lobe; the upper edges of the fifth segment squared not elevated; the inferior keels finely denticulated, a smooth crescentic area at the hinder end of its lower surface; *vesicle* studded beneath with setiferous pores, the conical spine beneath the aculeus thickly hairy; aculeus about half the length of the vesicle, gently curved.

*Palpi* punctulate above; the *humerus* granular at the base, with irregularly granular superior keels, finely granular in front also; *brachium* studded posteriorly with setiferous pores, the supero-anterior keel at most crenulate, the anterior surface smooth except for a vertical series of three fine denticles above at the base. *Manus* large, more than twice the width of the brachium, widely and evenly rounded internally, convex above, and obsoletely tricostate, the lower surface also obsoletely tricostate; the "hand-back" furnished with a single keel which runs obliquely backwards and upwards from above the lower articular facet of the movable digit; *digits* slender, not lobate, the movable a little longer than the width of the hand.

*Legs* smooth, the lower surface of the feet furnished with two rows of spines.

Pectines short, with 8-9 teeth.

♂. Much less smooth than the female, the carapace so closely punctured as to be finely rugulose; the upper surface of the hand adorned with a reticulated pattern of minute granules, the external and internal keel of its upper surface very strong. *Tail* longer, about  $4\frac{1}{3}$  times the length of the carapace, which is equal to the first caudal segment and  $\frac{2}{3}$  of the second. The pectines much larger, both the shaft and the teeth being longer.

*Measurements in millims.*—♀. Total length 44, length of carapace 6, of tail 24, of its first two segments 6, of the fifth 5.2; length of brachium 4.8, width 2; width of hand 5; length of hand-back 4, of movable digit 6.

♂. Total length 46, length of carapace 6, of tail 27, of its first two segments 7, of the fifth 6, of brachium 5, of hand-back 4, of movable digit 6, width of hand 5.2.

*Locality.* St. Lucia (*G. A. Ramage*); St. Vincent (*H. H. Smith*).

Of the described species of *Diplocentrus* this new form seems to differ from *D. Gundlachii* in that the 1st segment of the tail is the only one that contains 10 complete keels.

From *D. Whitei*, Gervais, a Mexican form, it differs in being smaller, in having fewer pectinal teeth, the inferior caudal keels not granular, the last abdominal sternite not costate, and slightly also in the shape of the external surface of the hand.

From *D. mexicanus*, Peters, which is possibly the male of *D. Whitei*, it also differs in not having the first four caudal segments furnished with 10 keels.

19. *DIPLOCENTRUS SCABER*, sp. n.

♀. *Colour* fusco-ochraceous, palpi ferruginous.

*Carapace* finely granular throughout, the area between the tubercle and the anterior excision not mesially sulcate.

The *tergites* also finely granular throughout.

The last *sternite* with four distinct, granulate, abbreviated keels.

*Tail* about the same relative length as in *D. antillanus*, with the intercarinal spaces finely granular and the keels distinctly crenulate or granular; the four anterior segments furnished with 10 keels each.

The palpi resembling those of *D. antillanus* in form; but the "hand-back" bounded by two distinct smooth keels, one starting from the upper and the other from the lower articular facet of the movable digit and passing backwards to the posterior border of the external surface of the hand.

*Legs* externally minutely granular.

*Pectines* short, furnished with 6 teeth.

Total length 34.5 millim., of carapace 4.3, of tail 17.5; width of 1st segment almost 3, length 2.

*Locality.* Jamaica (*P. H. Gosse*) and Barbados.

This species appears to resemble *D. mexicanus* of Peters (Mon. Ak. Wiss. Berl. 1861, p. 512) in having the dorsal surface granular and two keels on the back of the hand (*cf.* Karsch, Mitth. Münch. ent. Ver. 1879, p. 99). *D. mexicanus*, however, at least differs in being considerably larger (50–55 millim.), and in having a greater number of pectinal teeth (12 or more) (*cf.* Karsch, Zeits. Naturwissen. (3) v. p. 407, 1880).

Genus *OICLUS*, *Simon, Ann. Soc. Ent. Fr.* (5) x. pp. 397–398 (1880).

According to Simon this genus differs from *Diplocentrus* in



having the anterior border of the carapace lightly emarginate and only two lateral eyes on each side of it.

Type *O. Purvesii*, Becker.

20. \* *OICLUS PURVESII* (*Becker*).

*Diplocentrus Purvesii*, *Becker, Ann. Soc. Ent. Belg.* xxiv. p. 142, pl. iii. fig. 2 (1880).

*Oiclus Purvesii*, *Simon, Ann. Soc. Ent. Fr.* (5) x. pp. 397-398 (1880).

"*Carapace* elongate, granular on each side of the middle line and posteriorly at the sides.

"*Tergites* with three rows of tubercles, the posterior row along the hinder border.

"*Tail* four times as long as the carapace, with granular keels; vesicle elongate.

"*Hands* short, robust, granular above.

"*Pectines* with 7 teeth."

*Locality.* "Antigua."

Genus *OPISTHACANTHUS*, *Peters, Mon. Ak. Wiss. Berlin*, 1861, p. 511; *Thorell, Etudes Scorpiol.* p. 10.

*Carapace* deeply excised anteriorly, longitudinally sulcate throughout. Ocular tubercle near the middle. Three lateral eyes on each side.

*Tail* compressed, and rather short; vesicle without spine beneath the aculeus, which is short.

*Chelicerae* with superior terminal fang subequal to the inferior.

*Palpi* large, denticles of the digits almost as in *Diplocentrus*; the upper surface of the hand divided by a strong keel into two areas, the external of which is nearly vertical and meets the internal horizontal area at an obtuse or right angle, the vertical area separated by a strong keel from the "hand-back," which constitutes the external area of the lower surface of the hand.

Terminal tarsal segment of the *legs* furnished beneath with two rows of spines.

*Sternum* pentagonal, as wide as long, parallel-sided.

*Genital operculum* cleft in the male, its halves united in female.

*Pectines* short, the shaft very broad at the base owing to the width of the basal intermediate lamella.

*Stigmata* elongate.

Type, *O. elatus*, Gervais.

21. *OPISTHACANTHUS ELATUS* (*Gervais*).

? *Scorpio lepturus*, *Pal. de Beauvois, Insectes etc.* p. 191, *Apt.* pl. v. fig. 4.

*Scorpio elatus*, *Gervais, Arch. Mus.* iv. p. 235, pl. xii. figs. 46-49; *id. Ins. Apt.* p. 69.

*Opisthacanthus Kinbergii*, *Thorell, op. cit.* p. 172.

*Carapace* somewhat flat, wider than long; granular throughout; median eyes large, scarcely elevated on a tubercle; lateral eyes very prominent, the distance between the anterior and median twice as great as between the median and posterior, which are subcontiguous.

*Tergites* granular and rugose, the last not carinate, but furnished posteriorly with two small tubercles.

*Sterna* smooth, the last subcostate.

*Tail*  $2\frac{1}{2}$  times the length of the carapace, which is as long as the first two segments and more than half the third, narrowed posteriorly; the segments mesially excavated above, with rounded smooth edges, subcarinate beneath but granular only posteriorly; vesicle smooth, with long hairs beneath the aculeus.

*Palpus*: *humerus* denticulate in front and behind, the upper surface smooth distally; *brachium* with a strong denticulated crest at the proximal end of its anterior surface; *manus* coarsely granular above, rugose beneath, denticulate in front; the "hand-back" about as long as the movable digit, the width of the hand about  $\frac{2}{3}$  the length of the "hand-back"; the digits scarcely sinuate, and lobate at the base.

*Legs* with femora granular beneath.

*Genital operculum* heart-shaped, pointed posteriorly, nearly as long as wide, without trace of suture.

*Pectines* very small, only a little longer than the width of the operculum, furnished with 7 teeth.

♂. *Tail* a little more than three times the length of the carapace. *Digits* correspondingly lobate and sinuate. *Genital operculum* rounded, and not pointed behind. *Pectines* much larger, and furnished with 12 teeth.

*Measurements in millims. of adult male.*—Total length 87, of carapace 13, of tail 41, of "hand-back" 15, width of hand 11.

*Locality.* Hayti, according to specimens in the British Museum. It also occurs in Colombia.

Genus BROTEOCHACTAS, *Pocock*,

*Ann. Mag. Nat. Hist.* (6) xii. pl. v. figs. 2, 3.

*Anterior* border of carapace very lightly depressed in the middle, but not excised. The lateral eyes two in number; the anterior close to the margin of the carapace, the posterior a little above it, not or but little prominent. The tubercle of the median eyes far in front of the middle of the carapace.

*Sternum* wider than long, of the pentagonal type; its posterior border widely emarginate, equalling in width the maxillary lobes of the second coxæ.

*Pectines* short.

*Stigmata* oval.

The movable digit of the *chelicerae* not terminating in two subequal fangs, the upper one being short.

*Palpi* short, robust.

*Tail* robust, anteriorly smooth beneath.

*Lower* surface of the terminal tarsal segment of the legs ornamented with spiniform hairs, which are arranged more or less distinctly in two series.

Differs from *Chactas* in that the front of the carapace is not emarginate, the lateral eyes not prominent, the lower surface of the feet not compressed and not armed with a single series of spines, &c.

22. BROTEOCHACTAS NITIDUS, *Pocock*. (Pl. XXIX. figs. 7-7a.)

♀. *Colour* castaneous; legs, vesicle, and lower surface a little paler.

*Carapace* perfectly smooth and polished, marked with a Y-shaped groove, the two upper arms of which embrace the ocular tubercle; the anteocular portion not mesially depressed, the lateral portion sloped away.

*Tergites* perfectly smooth and polished, marked in front on each side of the middle with a shallow depression; the last tergite with four tubercles (sometimes six) corresponding to the four superior keels of the tail-segments.

*Sterna* smooth and polished.

*Tail* robust, narrowed towards its distal end, the upper surface smooth and polished, the first segment scarcely excavated longitudinally, the excavation increasing in depth to the fourth, the fifth flat posteriorly, excavated in front, the supero-lateral keels

well developed on the four anterior segments, shining but obsoletely crenulate; the superior keels represented by a single posterior tubercle on the first segment, visible on the others and obsoletely tuberculate or crenulate, the upper angles of the fifth not sharp but squared; the lateral and inferior surfaces of the first three segments smooth and polished, sparsely hairy, not keeled; of the fourth obsoletely keeled and granular, the lower surface of the fifth somewhat coarsely but irregularly granular, its posterior border denticulate. *Vesicle* piriform, coriaceous beneath, smooth and flat above, the aculeus stout at the base, somewhat strongly but evenly curved in its distal half.

*Palpi* robust; *humerus* with its keels weak but granular, its anterior surface flat, weakly granular; *brachium* smooth, obsoletely costate; *manus* large, convex above, its inner portion produced, smooth, obscurely and very feebly granular towards its inner edge, and very obscurely costate above, its width about equal to the length of the "hand-back," which is furnished with an oblique row of four piliferous pores. Digits short, curved, in contact, the movable a little longer than the length of the "hand-back," the immovable furnished with five piliferous pores; four more of these pores in a line on the external surface of the hand, lying between the bases of the two digits.

*Legs* smooth, except the inferior edge of the anterior two femora, which are granular; the distal tarsal segment with two rows of hairs beneath.

*Pectines* short, furnished with 7 teeth (one specimen with 8).

♂. Slenderer than female, the tail longer, being about  $4\frac{1}{2}$  times the length of the carapace. The upper surface of the hand very finely granular. *Pectines* larger, the teeth much longer, 8 in number.

*Measurements in millims.*—♀. Total length 38, of carapace 5, of tail 20; width of 1st caudal segment 3, length 2; length of 4th segment 3, width 2.5; length of 5th 5.5, width 2.5; length of palp 15.5; width of brachium 1.8, of manus 4, of "hand-back" 3.8, of movable digit 4.5.

♂. Total length 31, of carapace 4, of tail 19.

*Locality.* Trinidad (*W. E. Broadway* and *J. H. Hart*).

This species is very nearly related to *Chactas Gollmeri*, Karsch, from Caraccas, which probably also belongs to the same genus. Karsch, however, makes no mention of the presence of keels and granules upon the lower surface of the 4th caudal segment. Nor

in *Broteochactas nitidus* is the manus marked with many ocelli-form punctures arranged in three rows.

I also refer to this genus *Chactas delicatus*, Karsch, of which the British Museum has a large number of specimens from Demerara (British Guiana), a few ticketed S. America, and one from Colombia. The variety named *opacus* by Karsch is nothing but the male of *delicatus*.

Genus *HADRURUS*, Thorell, *Etudes Scorpior.* p. 9.

*Carapace* very closely resembling that of *Brachistosternus*, the lateral eyes a little larger and a little farther from the edge.

The digits of the *chelicerae* shorter than in *Brachistosternus*, and the teeth more robust; the terminal fang of the movable digit shorter; a large tusk on the lower border of this digit.

*Digits* of the chelæ denticulate as in *Brachistosternus*, but the denticles of the median series more numerous.

*Tail* as in *Brachistosternus*.

*Sternum* almost as in *Brachistosternus*, but larger and not entirely tucked in as in this genus. The genital operculum small, not in contact with the second pair of coxæ, cleft in both sexes.

*Pectines* long, with their intermediate lamellæ formed of a single series of rounded sclerites.

*Legs* as in *Brachistosternus*, but the terminal tarsal segments not carinate above.

Type, *H. hirsutus* (Wood).

23. \* *HADRURUS PARVULUS*, Karsch, *Mitth. Münch. ent. Ver.* 1879, p. 135.

"Very like *H. maculatus* of Thorell. Of smaller size. Colour testaceous, with longitudinal fuscous striæ on the upper surface of the abdomen.

"*Carapace* finely, abdomen very finely granular; tail smooth and shining above, the first and second segments with a few larger tubercles at the sides; the first segment with a complete median lateral carina, this carina incomplete on the 2nd and 3rd; the inferior lateral keels of the 4th segment smooth, the median absent, marked by punctures. The rest as in *H. maculatus*. Pectinal teeth 17.

"Length 37 mm., tail 20.

"*Locality*. W. Indies."

## BRACHISTOSTERNUS, gen. nov.

*Syn. Mecocentrus*, Simon; *Ann. Soc. Ent. Fr.* (5) x. p. 393.

*Carapace* longitudinally sulcate throughout, the sulcus passing over the tubercle, the anterior border lightly convex; the ocular tubercle in the middle of the carapace; lateral eyes three in number, minute, contiguous, just above the lateral border. The terminal fang of the movable digit of the chelicerae long, the fang at its base very short.

*Palpi* moderately strong; the digits armed with several short, oblique series of denticles, the posterior denticles of each series enlarged to form an external series of larger denticles; a corresponding internal series of denticles alternating with the external series.

*Tail* moderately long; the aculeus of the vesicle long, slender, and lightly curved.

*Stigmata* elongate.

*Sternum* almost invisible, owing to its having taken up a vertical position behind the coxae of the second pair of walking-limbs, distinctly of the pentagonal type, much wider than long, with its posterior border deeply emarginate.

The *genital operculum* very large, in contact with the coxae of the second pair of walking-legs, its two halves separate in both sexes.

*Pectines* long, the intermediate lamellæ formed of two rows of sclerites.

*Legs* long, the terminal tarsal segment carinate above, shortly hairy below.

Type, *B. Ehrenbergii* (Gerv.).

This genus is certainly synonymous with Simon's *Mecocentrus* and possibly with Thorell's *Telegonus*. But I cannot bring myself to believe that it is the same as *Telegonus* of C. Koch. This genus *Telegonus*, which was renamed *Mecocentrus* by Karsch\* on the grounds of the preoccupation of the name employed by Koch, was based upon a species *versicolor*†, which at least differs from *Brachistosternus* in the extreme thickness of its tail. A glance at the figure of *T. versicolor* shows that all the anterior caudal segments are considerably wider than long,

\* Zeit. Naturwissen. (3) v. p. 408 (1880).

† Die Arachniden, iii. p. 52, fig. 207 (1836).

whereas one of the characters that Simon gives for *Mecocentrus* is the fact that the caudal segments are longer than wide.

24. BRACHISTOSTERNUS EHRENBERGII (*Gervais*).

Scorpio Ehrenbergii, *Gervais, Voyage de la Bonite*, i. p. 282, pl. i. figs. 18-22; *id. Ins. Apt.* iii. p. 59, ♂.

Scorpio glaber, *Gervais, Voyage de la Bonite*, i. p. 285, pl. i. figs. 28-32; *id. Ins. Apt.* iii. p. 59, ♀.

Telegonus politus, *L. Koch, Verh. z.-b. Wien*, xvii. pp. 234, 235 (1867).

♀. *Colour* ochraceous, the tergites infuscate, the aculeus of the vesicle and the digits also infuscate.

*Carapace* smooth above, closely and finely granular at the sides, equalling in length the 5th caudal segment and the 1st +  $\frac{1}{3}$  of the 2nd.

*Tergites* very finely granular, with a median depression, the last much more coarsely granular, with a single granular keel. *Sternites* perfectly smooth.

*Tail* rather more than five times the length of the carapace, narrowed posteriorly, the upper surface only shallowly excavated; the lower surface of segments 1-4 entirely smooth beneath, being merely obsoletely subcarinate and symmetrically porous; the superior keels stronger, subgranular or crenulate, the granulation decreasing posteriorly; the 5th segment about twice as wide as long, the superior edges not carinate, very lightly crenulate, the upper surface entirely smooth, lightly depressed mesially, the lower surface finely granular, the three inferior keels strong and denticulate. Vesicle piriform, narrower than the 5th, a little wider than high; the aculeus long and very lightly curved.

*Palpi*: *humerus* smooth or nearly so in the intercarinal spaces, the keels granular; *brachium* smooth and not keeled posteriorly, weakly granular in front; *manus* round and smooth.

*Legs* with femora externally very finely granular.

*Pectines* with 32-33 teeth, overlapping the end of the coxæ by half the length of the distal sclerite of the shaft.

♂. More closely and coarsely granular than the female; the sternites distinctly coriaceous; the tail six times the length of the carapace, which is as long as the 1st and  $\frac{1}{5}$  of the 2nd segment, and also more robust than in the female, with two elongate pale spots on the upper surface of the 5th segment. *Hands* of the palpi more robust, with a conspicuous triangular tooth on its inner surface in front. *Pectines* longer, reaching almost to the extremity of the trochanter of the posterior legs.

*Measurements in millims.*—♀. Total length 77, of carapace 7·8, of tail 43; width of 1st segment 4·5, of 5th 3·8; width of brachium 2·5, of manus 3·6; length of hand-back 5, of movable digit 6·6.

♂. Total length 81, length of carapace 8, of tail 53; width of 1st segment 5·8, of 5th 4·8, length of 5th 9·8; width of brachium 3, of manus 5·5; length of hand-back 7, of movable digit 8.

*Locality.* W. Indies \*.

The British Museum possesses a single female example of this species, ticketed W. Indies, and belonging originally to the collection of the late Count Keyserling. The description of the two sexes has been drawn up from two other examples in the British Museum from Lima, which are certainly to my mind co-specific with the specimens Gervais had from Peru. The Antillean example has 34 pectinal teeth. The original example described from Peru has about 40 teeth.

## PEDIPALPI.

Very few species of this group have been recorded from the West Indies, as may be seen from the subjoined list, and neither of these are restricted in range to this area of the Neotropical Region.

### Suborder UROPYGI.

#### Family THELYPHONIDÆ.

*THELYPHONUS ANTILLANUS*, C. Koch, *Die Arachniden*, x. p. 29, fig. 773.

*Locality.* Hayti.

Of this genus no species have as yet been discovered in the Lesser Antilles. The only one known from the West Indies is the above, which seems to be not uncommon in Hayti.

### Suborder AMBLYPYGI.

#### Family TARANTULIDÆ.

*TARANTULA RENIFORMIS* (Linn.).

*Phalangium reniforme*, Linn. *Syst. Nat.* ed. 10, p. 619.

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\* This locality certainly needs confirmation.



*Tarantula reniforme*, *Fabr. Ent. Syst.* ii. p. 432.

? *Phalangium reniforme*, *Licht. & Herbst, Natursyst. ungeflüg. Insekten*, p. 79, pl. v. fig. 1 (not pl. vi. K.)

? *Phalangium palmatum*, *id. ibid.* p. 82, pl. iv. fig. 2.

*Phrynus margine-maculatus*, *Koch, Die Arachn.* viii. p. 6, fig. 597.

*Phrynus palmatus*, *id. ibid.* p. 13, fig. 601.

*Phrynus pumilio*, *id. ibid.* p. 15, fig. 602.

*Phrynus reniformis*, *variegatus*, *palmatus*, *fuscimanus*, *Butler, Ann. N. Hist.* (4) xii. pp. 118, 119.

*Phrynus Goesii*, *Thorell, Ann. Mus. Gen.* (2) vii. p. 530.

*Not Syn.* *Phalangium reniforme*, *Pallas, Spic. Zool.* i. pt. ix. pp. 34, 35, pl. iii. figs. 3, 4.

*Tarantula reniformis*, *Simon, Ann. Soc. Ent. Fr.* 1892, p. 51.

*Colour.* Carapace reddish brown or almost black, with some faintly indicated lateral marginal flavous spots and some fine stripes of the same colour radiating from the fovea externally and posteriorly; upper surface of the abdomen in well coloured specimens ornamented with black or deep brown and reddish or flavous spots, the spots alternating like the pattern of a chess-board, each tergite bearing 10 spots, 5 anterior and 5 posterior, the anterior row consisting of 3 black and 2 yellow spots and the posterior of 2 black and 3 yellow spots; palpi the same colour as the carapace; legs ferruginous or fuscous, with a faintly defined flavous spot on the external surface of the femur. Lower surface ferruginous or fulvous.

*Carapace* coarsely but not closely granular, its anterior border lightly emarginate and conspicuously dentate, the rest of the border denticulate.

The upper surface of the *abdomen* granular like the carapace.

*Palpi* rather short, but varying in length from about three times the length of the carapace to only a little more than twice the length; the brachium a little longer than the humerus, longer than the length of the carapace but shorter than its width. The *humerus* granular above and below, more weakly granular in front, its upper edge armed in its proximal half with from 5 to 6 (8) larger spines and some smaller ones; the second and third are the largest and the first rises from the base of the second; its inferior edge armed with about 8 larger and smaller spines, of which the first and second are considerably the largest. *Brachium* granular like the humerus, its upper edge armed in its distal half with 7 spines, of which the first and seventh are the

smallest, the rest are very long, but the fourth and sixth are a little shorter than the rest; its lower edge armed with 2 long and 3 or 4 shorter spines. *Manus* armed above with 3 spines, of which the second is much the longest, and some spinules; its lower edge armed with 1 long spine in the middle and 1 very much shorter one in front and behind it.

*Legs* thickly granular.

Measurements of largest specimen:—

Total length 34 mm., length of carapace along the middle line 12, its greatest length 14, width 19; length of abdomen 22, of humerus 15, of brachium 16.5, of manus and dactylus 13.

This species is very widely distributed in the northern parts of the Neotropical Region. The British Museum has examples from the following West Indian islands:—Cuba, Jamaica, Hayti, Bahamas, Montserrat, Martinique, Dominica (*Nicholls*), St. Lucia (*Ramage*), St. Vincent (*H. H. Smith*), Barbados (*H. W. Feilden*), and Trinidad. It has also been recorded from Porto Rico (*Karsch*), St. Bartholomew (*Thorell*), and Antigua (*Brown*).

In his recent revision of this family, M. Simon characterizes the genus *Tarantula*, of which *reniformis* (Linn.) is the type; but it seems to me certain that he has fallen into error in his identification of *reniformis* of Linn., and also in his diagnosis of the genus.

He states that Linnæus's description of *reniformis* can be applied to all the species of the family Tarantulidæ, and that Linnæus himself assigns the New World as its locality; consequently it is permissible to suppose that *reniformis* is the species which most often comes to us from Tropical America.

But Linnæus was very much more precise in this matter than M. Simon makes out; for in the tenth edition of the 'Systema' it is expressly stated that the description of *reniformis* is based upon the figure and description of a *Tarantula* published in Brown's 'History of Jamaica,' and this island is mentioned as the home of the species. As a matter of fact, upon this latter point Linnæus asserted more than he had warrant for; for Brown remarks that he had never seen the species in Jamaica, although it occurred in several of the West Indian Islands (Sugar Islands); his figure, he adds, was taken from a specimen from Antigua, which was lent to him by a friend. Now this figure, with its robust and short palpi, clearly represents the species that I have

characterized above as *reniformis*; and that it is the *reniformis* of Linnæus no one, I think, can dispute.

Moreover, I may mention that of all the Neotropical forms it is the one that has been far the most frequently sent to the British Museum.

The *reniformis* of Pallas, and presumably also of M. Simon, is quite a different species. It would have been to Pallas's credit if he had conceived the likelihood of this before censuring Brown for the inaccuracy of his figure. It would indeed have been odd if Brown's figure had fitted Pallas's specimen, seeing that the former was the representation of an example differing from the latter in well-marked specific, if not in generic, characters.

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### Supplementary Note on the Freshwater Decapod Fauna of St. Vincent.

In the 'Annals and Magazine of Natural History,' (6) iii. pp. 6-22 (1889), I published an account of the freshwater and land Decapoda obtained in Dominica by Mr. G. A. Ramage. The following list of the species of this group collected by Mr. H. H. Smith in St. Vincent shows that the Crustacean fauna of the two islands is very similar.

*PSEUDOTELPHUSA DENTATA* (*Latreille*).

*Thelphusa dentata*, *Latr. Encycl.* x. p. 564.

*Boscia dentata*, *Milne-Edwards, Hist. Nat. Crustacea*, ii. p. 15, pl. xviii. fig. 14.

*Pseudotelphusa tenuipes*, *Pocock, Ann. Mag. Nat. Hist.* (6) iii. pp. 7-9.

St. Vincent.

An examination of the series of examples of this species sent home by Mr. Ramage and Mr. Smith has convinced me that they are probably after all to be referred to *P. dentata* of Latr. Milne-Edwards's figure of the dactylar segment of the legs, upon which I formerly relied, is most likely inaccurate.

*PALÆMON JAMAICENSIS* (*Herbst*)\*.

*Vide* Ortmann, *Zool. Jahrb.* v. p. 729.

Cumberland and Chateaubilair Rivers.

\* In my Report upon the Crustacea of Dominica I wrongly followed Mr. Spence Bate in terming this genus *Bithynis*.

PALÆMON OLFERSII, *Wiegmann*.

Palæmon Olfersii, *Wiegmann, Arch. Naturg.* 1836, p. 150.

Palæmon spinimanus, *M.-Edwards, Crust.* ii. p. 399.

Palæmon Olfersii, *Ortmann, Zool. Jahrb.* v. p. 733.

Cumberland, Chateaubilair, and FitzHughes Rivers.

PALÆMON FAUSTINUS, *Saussure*.

Palæmon faustinus, *Saussure, Mém. Crust. nouveaux du Mexique et des Antilles*, p. 53, pl. iv. fig. 30 (extract from *Mém. Soc. Phys. Genève*, 1858); *Ortmann, op. cit.* p. 734.

Cumberland and FitzHughes Rivers.

This species and *P. Olfersii* are possibly not distinct.

PALÆMON APPUNI, *von Martens*.

Palæmon appuni, *von Martens, Arch. f. Naturg.* xxxv. p. 31, pl. ii. fig. 5; *Pocock, Ann. Mag. Nat. Hist.* (6) iii. pp. 10-11, pl. ii. fig. 2; *Ortmann, Zool. Jahrb.* v. p. 722 (1891).

Cumberland and FitzHughes Rivers.

I reported this species with some hesitation from Dominica, having only one specimen for examination. The series, however, obtained by Mr. Smith has conclusively, to my mind, settled the question of the correctness of my identification.

ATYA OCCIDENTALIS, *Newport*.

Atya occidentalis, *Newport, Ann. Mag. Nat. Hist.* xix. p. 158 (1847); *Pocock, loc. cit.* pp. 11-16, pl. ii. fig. 3.

Cumberland and FitzHughes Rivers.

CARIDINA AMERICANA, *Guérin*.

FitzHughes River.

XIPHOCARIS ELONGATA, *Guérin*.

FitzHughes River.

The examples of this species that were obtained are of interest inasmuch as they serve largely to bridge over the structural interval between *X. elongata* and the form from Dominica to which I gave the name *intermedia*.

## EXPLANATION OF THE PLATES.

## PLATE XXIX.

Fig. 1. *Tityus insignis*, Pocock, nat. size.

- 1 a. " " " extremity of tail.
- 2. *Tityus americanus* (Linn.), extremity of tail, from below, ♂.
- 2 a. " " " " " from the side, ♂.
- 2 b. " " " " " manus of ♂.
- 3. *Tityus androcottoides* (Karsch), tail of ♂ from below.
- 3 a. " " " " " extremity of tail of ♂ from the side.
- 3 b. " " " " " manus of ♂.
- 4. *Tityus melanostictus*, sp. n., ♂, nat. size.
- 4 a. " " " " " ♂, manus.
- 4 b. " " " " " extremity of tail.
- 5. *Centrurus nitidus*, Thor., ♀, nat. size.
- 5 a. " " " " " extremity of tail, ♂.
- 5 b. " " " " " " " ♀.
- 6. *Diplocentrus antillanus*, sp. n., nat. size.
- 6 a. " " " " " extremity of tail.
- 7. *Broteochactas nitidus*, Pocock, nat. size.
- 7 a. " " " " " extremity of tail.

## PLATE XXX.

Fig. 8. *Tityus pictus*, sp. n., ♂, nat. size.

- 8 a. " " " " " extremity of tail.
- 9. *Tityus Smithii*, sp. n., ♂, nat. size.
- 9 a. " " " " " extremity of tail.
- 10. *Tityus obtusus* (Karsch), ♂, nat. size.
- 10 a. " " " " " extremity of tail.
- 11. *Centrurus testaceus* (De Geer), ♀, nat. size.
- 11 a. " " " " " extremity of tail.
- 12. *Centrurus insulanus*, Thor., ♀, nat. size.
- 12 a. " " " " " extremity of tail.
- 12 b. " " " " " ♂, extremity of tail.

Notes on the *Chernetidæ*, with special Reference to the Vestigial Stigmata and to a new form of Trachea. By HENRY M. BERNARD, M.A. (Cantab.). (From the Huxley Research Laboratory, Royal College of Science, London.) (Communicated by W. PERCY SLADEN, Sec. Linn. Soc.)

[Read 20th April, 1893.]

(PLATES XXXI. & XXXII.)

IN a short paper\* containing additional evidence as to the origin of tracheæ from setiparous sacs, I stated that I had discovered an *Obisium* which, in addition to the ordinary two pairs of stigmata on the second and third abdominal segments, had also seven pairs of rudimentary, or rather vestigial, stigmata on the seven remaining abdominal segments.

The specimen on which these vestigial markings were first found was brought from the Thüringer Wald, and was macerated in boiling caustic potash (figs. 1 & 1 a, v.s.). I am now indebted to Dr. Günther, F.R.S., for kindly placing at my disposal six alcohol specimens from bottles labelled "*Obisium museorum*" and "*O. sylvaticum* or *carcinoides*." Of these, four were cut into serial sections; one, owing to some extraordinary hardness in the abdomen, resisted all efforts to cut it, the razor bending and sliding over it; the remaining specimen was boiled in caustic potash.

No trace of these vestigial stigmata could be found in the sections, but in the macerated specimen (labelled *O. sylvaticum*, figs. 2 & 2 a) they were immediately found, though differing in position from those on the Thüringer specimen. The object of this paper is to describe the results of my investigation of these interesting markings. At the same time, a brief description of certain new points which have come to light in the course of this investigation can hardly fail to be of interest. Since Menge (6), there has been only one paper (by Croneberg (2)) dealing specially with the anatomy of the Chernetidæ, although observations on single points have been recorded.

The outer form of the Chernetidæ requires no description. The chief point of importance morphologically is the relation of the basal regions of the chelicerae to those of the pedipalps. The Chernetidæ agree with *Galeodes*, the Araneidæ, and, so far

\* Ann. & Mag. Nat. Hist., Jan. 1893.

as I can ascertain, with *Schizonotus*, in having the basal parts of the pedipalps directly under, or ventrally to, the basal regions of the mandibles, which form the "cephalic lobes" \*.

In this ventral position of the basal regions of the pedipalps, the Chernetidæ are more primitive than *Scorpio*, in which the same parts have been forced up laterally by the crowding forward of the legs towards the anterior end of the body. The result of the arrangement in the Chernetidæ is curious: owing to the enormous size of the pedipalps, and the consequent development of their muscles, nearly half the ventral surface of the cephalothorax is taken up by the coxal joints of these limbs (fig. 2). The four leg-bearing segments, which are fused together at least ventrally, are entirely confined to the posterior half of the cephalothorax.

Although there is no waist or diaphragm as in so many other Arachnids, there are very deep lateral infoldings of the skin between the sixth and seventh segments (figs. 2 & 12, *i.*). And further, the ventral segmental constriction between the sixth and seventh segments is very deep, which would allow the abdomen to be raised. These may be the first beginnings of a waist.

The Chernetidæ agree with *Galeodes* in possessing a rostrum or beak, which consists essentially of two parts, a dorsal "labrum" and a ventral "labium" †. The former is flattened laterally; its tip is thin-skinned, and in "*Obisium museorum*" curiously divided in the median line, so that in horizontal sections it looks as if it were produced into two horns (fig. 5); this part is probably sensory. The mouth is on the ventral surface, and closed by the wedge-shaped labium which fits into the oral aperture as shown in the transverse section (fig. 4). This pointed labium is apparently quite rigid, and reminds us of the remarkable process between the pedipalps of *Phrynus*, which may be a homologous structure. Further, in *Scorpio*, short as the labium is, it is of essentially the same shape when examined in serial sections.

In *Galeodes*, the mouth is at the tip of the rostrum. In the

\* My use of this term is explained in a short note on the "Head of *Galeodes* and the procephalic lobes of Arachnidan embryos," in the 'Zoologischer Anzeiger,' no. 426, 1893.

† I use these terms to indicate the homologies which I think are the most natural. I cannot see what is gained by endeavouring to deduce the rostrum from fused limbs (Croneberg (3)).

position of the mouth, the Chernetidæ come midway between *Galeodes* and *Scorpio*. The interesting homologies of these mouth-parts I propose to discuss fully in a paper on the Galeodidæ which is now in preparation.

On the inner anterior edges of the basal joints of the pedipalps there is a pair of movable lamellate processes (fig. 5), which, from the strength of their muscles, clearly serve to hold prey in front of the mouth, and perhaps to squeeze the juices out of soft bodies. The homologous processes in nearly the same position in *Galeodes*, *Phrynus*, and *Thelyphonus* are quite immovable, and appear to be sensory. In the Mygalidæ and Scorpionidæ they are still clearly traceable, but apparently much degenerated.

The endosternite in the Chernetidæ is especially interesting, and affords additional evidence of the apodematus origin of this structure, so patent in the Galeodidæ. The endosternite in these animals owes its origin to apodemes formerly present between the leg-bearing segments which are now completely fused together. We accordingly find it situated far back in the cephalothorax. It is now simply a small firm centre from which muscles radiate to the four pairs of legs and to the genital operculum (fig. 11).

### *The Muscular System.*

The muscular system of *Chernes* is comparatively simple. It is essentially of the same type as that of the Araneids. The chief differences found in the musculature of Arachnids depend upon the mobility of the coxæ. In *Galeodes*, in which the coxæ are fixed, all the muscles which in the Araneids move these joints are either wanting or are modified for other functions. In the Chernetidæ the coxæ are movable, but not to the same extent as in the Araneids. We consequently have a system of muscles arising from the lateral and dorso-lateral regions of the cephalothorax for the rotation and raising of the coxæ. As a rule, the muscle which rotates and moves the coxa one way crosses that which rotates it in the contrary direction. In addition to these rotating muscles which, when acting together, must lift the coxa, the muscles from the endosternite apparently also serve as elevators. I could find no body-muscles attached to the trochanter. All the leg-muscles proper are confined to the coxal and other joints.

The upper lip is provided with remarkable transverse muscles,



found also in the upper lip of *Scorpio* and of the Araneids (fig. 4). The under lip is raised by a pair of muscles descending on each side from the dorso-lateral sclerite of the basal joint of the pedipalp.

The muscles of the mandibles are, as is the case in all the Arachnida, confined entirely to the "cephalic lobes," *i. e.* to the region which in other Arachnids corresponds with the lobes forming the so-called head of *Galeodes* \*.

Powerful muscles run from the sides and back of the cephalothorax into the abdomen, serving to raise the latter, and perhaps also to move it from side to side.

There are seven pairs of dorso-ventral muscles in the abdomen, commencing in the first abdominal segment. These muscle-bands, which slope downward and outward, are attached dorsally to the tergites on each side of the dorsal vessel or dorsal blood-sinus, and ventrally to the sternites. They cause regular constrictions of the lateral diverticula of the alimentary canal (fig. 6).

The abdominal papillæ, through which the glands formerly thought to be the spinning-glands open, appear as if they could be raised and depressed, *i. e.* by raising the chitinous folds from which they are differentiated (fig. 10). The muscles marked  $m_1$  in the figure appear to be elevators, those marked  $m_2$  depressors (found only for the posterior papilla).

Histologically, the muscles are like all Arachnidan muscles; each fibre consists of a medullary axis of sarcoplasm with transversely striated bands arranged radially around it as a cortical layer.

### *The Alimentary Canal.*

The alimentary canal offers many points of special interest. Its general form has been already rightly described and figured by Croneberg.

Inside the mouth, the passage is both dorsally and ventrally finely striated transversely, as in the Araneidæ. On leaving the beak, the œsophagus suddenly swells into a sucking apparatus, which has already been accurately described by MacLeod (5), although I agree with Croneberg in disputing the rudimentary condition of the organ. The dorsal expanding muscles are attached to an apodeme between the mandibles and the pedipalps,

\* *Cf.* note on p. 411.

which extends backward in the median line to form an arch over the sucking apparatus, and is an extension backward of the dorsal surface of the labrum. The lateral expanding muscles are attached to the outer sides of the coxal joints of the pedipalps. In *Galeodes* this sucking apparatus is not so specialized, and the œsophagus can be expanded and contracted almost along the whole beak. *Obisium*, therefore, in the formation of its mouth-parts, comes halfway between *Galeodes* and the Scorpion, which latter has no freely projecting beak, but has a small specialized sucking apparatus in the same position as in *Obisium*.

On leaving the sucking apparatus, the œsophagus again narrows to pass through the central ganglionic mass, widening again at once into a great system of diverticula which fill the whole body (fig. 6). There seem to be two pairs of primary diverticula. The first pair must be subject to fluctuations in size, as they sometimes reach to the dorsal surface, and at others lie beneath the massive coils of the spinning-glands (fig. 9), which, as we shall see, are very differently developed at different times. This first pair fills all the space in the cephalothorax not occupied by other tissues. It must be considered as the equivalent of the four pairs which typically belong to the four posterior cephalothoracic segments in Arachnids. The fusion of the four leg-bearing segments above described will account for the fusion of the four pairs of originally separate diverticula. In *Scorpio* the four pairs of diverticula have also fused to form one pair, this being due to the longitudinal compression of the whole cephalothorax.

The second pair is the more important. Its two branches run laterally the whole way down the dorsal surface of the abdomen, sending down secondary diverticula laterally and ventrally. These secondary diverticula are due to the constrictions caused by the six posterior pairs of dorso-ventral muscles (fig. 6). The muscular passages thus formed between the secondary diverticula will be referred to again. About the same place where these two diverticula diverge, there is a median ventral primary diverticulum. A similar median ventral diverticulum has been described by Schimkievitch\* and Bertkau† in the Spiders.

\* "L'Anatomie de l'Épéire," Ann. d. Sciences Nat., Zool. xvii. (1884).

† "Ueber den Bau und Function der sog. Leber bei den Spinnen," Arch. f. Mikr. Anat. 23 Bd. (1884).

A short distance after the divergence of these three diverticula the main trunk of the canal suddenly narrows to form what may, perhaps, be the hind-gut. This forms a loop, running backward to nearly the end of the body, bending forward again and then backward. Just before the anal aperture, it widens to form a kind of stercoral pocket, which is, however, by no means so specialized as are the homologous structures in *Galeodes* and the Araneids. The anus is *apparently* a transverse slit, but in reality it is a median slit hidden in a transverse fold in the cuticle.

The epithelium of this intestinal tract shows but slight differentiations. From the proximal end of the œsophagus to the commencement of the "hind-gut," the cells are absolutely alike; there is apparently no division of labour; each cell performs all the functions of digestion, like an independent unicellular organism. In *Obisium* the cells are large and lobate, stretching out far into the lumen. The food absorbed by them is transformed into homogeneous globules which look exactly like oil-drops. These are so numerous that the nucleus is completely obscured. There is occasionally a peripheral layer of granular protoplasm, traces of which may also be found between the food-globules.

On close examination these food-globules are found to become granular, and ultimately to break down into a number of minute crystal-like bodies. These latter are regularly excreted between the cells and cast out in a stream, apparently in some slimy substance, into the lumen of the gut, to mix freely with the undigested food. Where the alimentary canal suddenly narrows to form the hind-gut, these "crystals" are separated from the food, and from this point they alone are to be found, which accounts for Menge's statement that fæcal formation commences at this point, whereas, as a matter of fact, it is at this point that the fæcal matter is separated from the other contents of the canal.

I have not hesitated to call these crystalline bodies fæcal, as it seemed clear to me that they were the undigested remains of the food-globules in the individual cells; they are found, apparently unchanged, as by far the most important if not the only constituent of the fæcal masses in the stercoral pocket. There can therefore be very little doubt that they are the irreducible remains of ingested food.

While examining these small refractive granules I was

strongly reminded of the similar crystalline bodies found in *Amœbæ*. On referring the matter to my friend Mr. Moore, he informed me that he had himself come to the conclusion that the so-called "crystals" of *Amœbæ* are the indigestible remains of food-globules, which in these animals also are almost indistinguishable from oil-drops. Mr. Moore's conclusions were already in print\*, otherwise this complete and unexpected confirmation of them would no doubt have been mentioned.

In one specimen, infected with bacteria, these large digesting cells, while apparently retaining their purely digestive functions, seem to be unable to get rid of the excreted matter which accumulates between the cells, as shown in fig. 8.

These simple conditions of the digestive processes in *Obisium* are of great importance. They have enabled us to recognize the supposed secretions of the "liver" cells of the Arachnids as no true secretions, but as homogeneous food-globules, and the various forms of "crystals" found in the cells as the fæcal remains of these food-globules. It follows, therefore, that the whole subject of the digestion of the Arachnids, so ably worked out by Plateau† and Bertkau‡ from the old point of view, should be restated from the new point of view above described, that the cells lining the diverticula of the alimentary canal are not glandular cells filled with their secretions, but digesting cells whose contents are to be referred to food in various stages of digestion. I have endeavoured to follow up this subject in a paper read before the Royal Microscopical Society and since published in that Society's Journal (Aug. 1893).

Outside the basement-membrane of the digesting epithelium is a layer of single cells homologous with the "fat body," described by Bertkau as occurring between the "hepatic" diverticula of the Araneids. These peritoneal cells vary considerably in shape, in some places being almost tile-shaped, and in others long and cylindrical. This latter form is sometimes found when these cells form part of the boundary of a blood-sinus, where they are free to develop. In places, on the other hand, where they are liable to be squeezed between adjacent parts of the

\* Ann. & Mag. N. H., Feb. 1893.

† "Recherches sur la structure de l'appareil digestif et sur les phénomènes de la digestion chez les Aranéides dipneumones," Bulletin de l'Acad. Royale de Bruxelles, 2<sup>e</sup> Série, tom. 44 (1877).

‡ L. c. p. 414.

gut, they are vacuolated to such an extent as to form a sponge-like connective tissue, the large nuclei being suspended on the threads. The boundaries of the individual cells, however, can still be made out. Without such an arrangement as this, there could be very little free movement of fluids within a body so completely filled up by mid-gut diverticula. The bacteria in the pathological specimen alluded to on the preceding page seem to form nests in these cells (fig. 8).

Just as the undifferentiated epithelium immediately round the opening of the œsophagus suddenly changes into the large digesting cells above described, so with like abruptness, when the intestine narrows to form the hind-gut, do these cells change into an epithelium of short thick cells with very large nuclei. These line the whole of the portion which I have called the hind-gut, as far, that is, as the enlargement answering to the stercoral pocket of other Arachnids. In the uppermost and last coil of the loop these show signs of being highly amœboid and vacuolated (fig. 7). Here and there the whole lumen of the tube is found to be filled with two or three cells distended by immense vacuoles, the nucleus being visible simply as a large body suspended in a fine membrane.

Croneberg found no Malpighian tubules in *Chernes Hahnii*, and I have entirely failed to find any trace of them in *Obisium*. The apparent entire absence of these organs in the Chernetidæ is somewhat remarkable, as these tubules are enormously developed in *Gibbocellum* according to Stecker's description and figures (8). The Chernetidæ, on the other hand, are not ill-provided with glands, as we shall see below. We shall perhaps obtain some insight into the physiological significance of this absence of Malpighian vessels in these animals when we have a tabulated survey of those glands which in the Arachnids serve to remove waste products from the body. I propose to draw up such a list of the glands in the Arachnids in a more comprehensive work dealing with the comparative morphology of the Galeodidæ.

### *The Circulatory System.*

On account of the minuteness of the heart and the limited supply of material at my disposal, I have been unable to throw much light on the disputed question as to the number of ostia. Winckler discovered only one terminal pair; Croneberg finds

three pairs, and Daday four pairs in the cylindrical part of the dorsal vessel, and, in addition, four extra openings in a rosette-like terminal portion.

In a series of transverse sections, I found that in the dorsal median line above the hind-gut (*cf.* figs. 6 and 7) there existed a blood-sinus full of coagulum, but without any trace of a dorsal vessel. The heart or dorsal vessel commenced (working from behind forward) where the hind-gut joined the mid-gut. I should therefore be inclined to think that there could be only one pair of ostia in the abdomen. Whether there are any in the cephalothorax I was unable to ascertain.

A cross section of the expanded heart might almost be mistaken for that of *Scorpio*. There is even a pair of fibrous bundles attached to the ventral surface, and drawing down the pericardium into the long conical processes which we find in *Scorpio*, the muscular attachments of which have been called by Lankester\* the veno-pericardial muscles.

The blood collected by the heart from the median dorsal sinus and the pericardium is driven forward through the coils of the spinning-glands; after circulating in the anterior regions of the body, it returns along the ventral surface, finding its way to the heart again through the constrictions (*m.d.*, figs. 6 and 8) of the diverticula formed by the dorso-ventral muscles and in the median plane between the mid-gut diverticula, bathing the hind-gut on its way into the median dorsal sinus.

In the pathological specimen (p. 416), the globular nests of bacteria are found chiefly in the walls of the passages formed by the dorso-ventral muscles which were enormously stretched by coagulated blood (fig. 8).

### *Glands.*

The spinning-glands were always supposed to be near the genital aperture, where also, according to Stecker, they occur in the related (?) form *Gibbocellum*. The important discovery by Croneberg, that they are really in the cephalothorax and emerge behind the tip of the movable joint of the mandibles, I have been able fully to confirm. At the same time, the view of the older zoologists was not altogether wrong; there are glands which

\* Lankester and Beck, Trans. Zool. Soc. vol. xi. pt. 10.

occur near the genital aperture, which might very easily be mistaken for spinning-glands. To these we shall return.

The fine chitinous ducts of the true spinning-glands open, in *Obisium*, on a blunt prominence at the back of the movable digits of the mandibles; they can be seen running down these limbs, about seven in number, and not more than  $1\mu$  in diameter (see fig. 2 *a, d*). These seven or more ducts lead into as many somewhat coiled cylindrical reservoirs ( $6\mu$  in diameter), which again gradually pass into the secreting portions of the glands. These, the glands themselves, run more or less straight backward immediately under the dorsal wall of the body, sometimes reaching into the second or third abdominal segment. The cells composing the wall were so packed with granules that I entirely failed to discover any nuclei. In glands which appear to be degenerating, the granules were fewer and the cells seemed to be breaking down. In these cases a fine staining-reticulum can be seen running among the granules; this and the trace of staining round the periphery of the gland are the only signs of protoplasmic arrangement I could perceive, besides the fine radially arranged lines bounding the separate cells. These glands are accompanied by a number of exquisitely fine tracheal tubules. The homology between these spinning-glands and the poison-glands of the Araneids is obvious. I do not think that the absence of the very specialized muscle-layers in the latter is a point of importance.

These glands seem to be subject to periodical variations; Croneberg found them most fully developed in summer. One of my specimens shows no other trace of them than their chitinous ducts in the mandibles.

The extremely thin and transparent combs on the mandibles, said to be used as manipulators of the silk, are formed by folds of the external hard refractive layer of the chitinous cuticle.

The abdominal glands open by median papillæ. The anterior papilla projects from the anterior edge of the second segment, and opens under the genital operculum. The posterior papilla is similarly situated at the anterior edge of the third segment, and is covered by the segmental fold of the second segment. *Gibbocellum* has spinning-glands on the second abdominal segment, and Stecker suggests their existence on the third segment also.

Stecker describes the glands in *Gibbocellum* as opening through a number of minute papillæ, in which case they would

probably be true silk-glands. It is worth recording, however, that the same kind of openings have been claimed for these abdominal glands in the Chernetidæ.

The anterior papilla opens into a short duct, into which, laterally and dorsally, groups of large pyriform glands pour their secretions. These glands are so crowded together that the secreting epithelium can properly develop only at their proximal ends, where the cavity is very deep, the cells in section being polygonal owing to mutual pressure (fig. 11).

The posterior papilla leads into a tuberos gland, the exact nature of which it is not easy to make out. The epithelium is like that of the pyriform glands, but the lumen looks like a shrunken chitinous sac (figs. 10, 11, 12).

These glands were developed only in one of the specimens at my disposal (figs. 10, 11). In the other three specimens, traces of them were visible in one; in a second the part was unfortunately torn away from the sections; while in the third there was no trace of them whatever. Evidently, therefore, these glands are, like the true spinning-glands, liable to periodic variations. I may further remark that the only specimen which shows these abdominal glands is the specimen which shows no trace of the true spinning-glands. It is true that my sections are here somewhat broken, but I do not doubt that this is the case. If so, we have here an interesting relation between the spinning-glands and the abdominal glands.

The presence of true spinning-glands on the mandibles, with their manipulating combs, seems to indicate that these abdominal glands are not the producers of the silk for the nest, though the secretion itself in these latter may be somewhat of the same nature as in the former; the largeness of the single apertures shows that they have nothing to do with the spinning of silk. On the other hand, the opening of the more important of the abdominal glands under the genital operculum would imply some connection with reproduction. Croneberg calls them "Kittdrüsen" (cement-glands). The function of these cement-glands is perhaps that of sticking the eggs to the abdominal surface of the mother, as there are several notices in literature that these animals carry about the eggs firmly attached to the ventral surface of the anterior abdominal segments. If this is the case, then it appears as if the male shared with the female the discharge of this function, because from the occurrence of the



"ram's-horns," presently to be noticed, the specimen shown in fig. 11 ought, according to Menge, to be a male. According to Croneberg, the abdominal glands are developed both in the males and the females, though presenting slight differences in the two sexes.

The coxal glands are blind tubes with the characteristic walls. The ground-substance of the wall often stains very badly, and appears to be perforated by branching pores, which give the whole a spongy appearance. It is doubtful, however, whether this is the true account of its structure. Nuclei are found in the wall, as shown in fig. 13. The epithelium round the commencement of the tube is very little differentiated. The aperture, which Sturany \* failed altogether to find, is on the posterior face of the coxa of the third leg; the Chernetidæ corresponding in this respect with *Scorpio* †. The gland runs inward and forward, whereas in *Scorpio* the gland runs from the aperture inward and backward, owing to the shifting forward of the limbs.

The duct of the gland is coiled, but the coil it makes is not very complicated. Fig. 14 is a reconstruction of the gland from a series of camera-lucida drawings. The blind end of the tube is practically enveloped by the coil. The whole gland is separated from the alimentary canal by the peritoneal cells, which we have already described as investing the whole of the mid- and hind-guts.

### *The Tracheæ.*

The tracheæ open through long slit-like stigmata, from the inner end of which the trunk slopes inward and forward; both the aperture and the trunk are protected by forked hairs projecting into the cavity. It is not easy to see whether these slit-like stigmata are open furrows, or closed tubes, with an opening only at their inner ends (Croneberg). An examination of the specimen shown in fig. 1, where the cuticle is folded, seems to show that the former description is the correct one. The proximal end of the trunk is somewhat widened, and gives rise to an enormous number of fine tubules. These tubules are intracellular. Near their points of origin the protoplasm containing

\* "Die Coxaldrüsen der Arachnoideen," Arb. Zool. Inst. Wien, t. ix, 1891.

† "The Coxal Glands of *Scorpio*," Ann. & Mag. N. H., July 1893.

the nucleus is seen surrounding them in a thick layer. This protoplasmic investment of the tubules gradually fades away as they spread out through the body until it is no longer demonstrable; indeed, the tubules themselves are so fine that they can be seen only with high powers. The tubules from the anterior pair of tracheæ run forward, from the posterior pair backward, at least in some cases; I could discover no anastomosings or branchings among these tubules.

In addition to these stigmata, there are rudimentary or vestigial stigmata on all the remaining abdominal segments. The claim that stigmata occurred on all the segments was, curiously enough, made so long ago as 1816 by Treviranus\*; but, as has been already often pointed out, he mistook the indentation of the cuticle caused by the dorso-ventral muscles for stigmata, and claimed them equally for the dorsal and ventral surfaces. The markings which I claim to be vestigial stigmata are much more definite (figs. 1, 2, and 3); the last figure represents one of the vestigial stigmata (from fig. 2) magnified 2000 times, to show what a definite scar-like mark it is. It appears to be completely closed. That these markings have been overlooked is hardly to be wondered at, as they can be seen only on cleanly macerated specimens with a high (300-500) magnifying power.

There can, I think, be little doubt that these are indeed vestigial stigmata†. Fig. 1 shows how closely in that animal (the *Obisium*, sp., from the Thüringer Wald) they agree, in position and in their relations to the setæ, with the functional stigmata. In fig. 2 we find them in quite another position. This difference in position is exactly what we find in other Arachnids; in some the stigmata are wide apart, as in *Scorpio*; in others (*Galeodes*) they almost, and sometimes even quite, meet in the ventral middle line. This movement of the stigmata is to be attributed to the change of the position of the blood-sinuses owing to the development of the digesting diverticula. When the diverticula develop so as to leave a median ventral blood-sinus, as in *Galeodes*, the stigmata also wander towards the middle line.

\* Vermischte Schriften, Bd. i. p. 15, 1816.

† Had there been only two of these rudimentary markings, *i. e.* on the two segments following those which have the functional stigmata, no one would have hesitated for a moment to claim them as the homologues of the third and fourth stigmata of *Scorpio*.

This striking difference in position shown by the vestigial stigmata is rather remarkable, occurring within a well demarcated group such as the Chernetidæ. I would, however, point out that the difference in the number of the abdominal segments claimed for different genera is almost equally surprising. The group is an extremely difficult one to classify; and I am afraid that these vestigial stigmata, visible only on carefully macerated specimens, will not make the task easier, although it is obvious that they are of prime importance for establishing a natural classification of the group.

These nine pairs of stigmata on the abdomen, rudimentary and functional, make it almost certain that the primitive Arachnid had tracheal invaginations on every segment. In the cephalothoracic segments these tracheæ have, as a rule, disappeared, owing to the compression of the six segments which form this region. We have cephalothoracic tracheæ, however, in *Galeodes*, in which the cephalothorax is jointed, and in certain *Acarines* which have failed to develop the abdominal segments. Further, only a certain number of the abdominal tracheæ have persisted; the anterior pairs have become, as a rule, specialized, while the posterior pairs have disappeared.

In addition to these stigmata, functional and vestigial, the remarkable "ram's-horn" organs, described by Menge and again by Croneberg, deserve special attention. It is claimed that these organs are present in the males of all species and genera. I succeeded in finding them only in one specimen, presumably the only male; its actual sex cannot now be determined, as the genital glands have suffered from the attacks of the infesting bacteria above referred to. In this single case, however, these organs present features hitherto unnoticed, which go far to establish Croneberg's belief that they must be homologous with tracheæ.

They are large chitinous tubes, the walls of which are much folded transversely, so that they are capable of considerable extension. I doubt, however, whether this is the object of the folding: it is rather for the sake of flexibility. They open laterally under the genital operculum, which thus protects their orifices. Menge says they are often conical, sometimes ram's-horn-like; they have this latter form in my specimen. From their apertures they rise dorsally, then bend forward, dipping down ventrally in a curve, the whole figure described being

somewhat like a ram's-horn (fig. 12). The organs in my specimens are beset with air-chambers closely packed between the muscles and inner organs, wherever, in fact, there has been room for their development.

Croneberg describes these organs as being invested by an epithelium of "small cells .008 millim. high." I could not find any very clear traces of this epithelium, but the air-chambers appeared to be developed within cells, the nuclei of which could occasionally be seen in a fine layer of protoplasm (fig. 12 *a*).

Menge, who recognized their remarkable likeness to tracheæ, believed these organs to be transmitters of sperm, and says that they are sometimes found turned inside out like the finger of a glove, and protruding from under the genital operculum; and Simon\* has a figure in which they are seen hanging out, extending one to the anterior and the other to the posterior end of the body! Whatever this evagination of these tubes may mean, it certainly requires investigation, but in the meantime the mere fact of their opening under the genital operculum in no way necessitates their having any connection with reproduction, as Croneberg seems to think, although he inclines to the belief that they are homologous with tracheæ. The view that they are transmitters of sperm, the latter finding its way into the tips of the tubes which are then evaginated, seems on the face of it so very improbable that it could be accepted only on the most unmistakable evidence.

We have, then, the two views:—(1) The old view that they are reproductive; and (2) the suggestion here made that they are respiratory.

In favour of the first view, we have the following arguments:—

(*a*) They occur under the genital operculum, close to the genital aperture.

(*b*) They have no protective stigmata.

(*c*) They are often found evaginated.

(*d*) They are said to be confined to the males.

In favour of their being respiratory, the following arguments may be used:—

(*a*) Their resemblance to tracheæ.

(*b*) Their position under the genital operculum, *i. e.* in close connection with rudimentary limbs, which is typical of tracheæ.

(*c*) Their occurrence on the 1st abdominal segment is quite

\* 'Les Arachnides de France,' vol. viii. 1879, p. 3, pl. xvii. fig. 4.

in keeping with the view that at one time there were tracheal invaginations in every segment.

(*d*) Their position enables them to dispense with protective stigmata. The operculum forms an effective covering for them as well as for the genital opening.

(*e*) The air-chambers, described and figured in this paper, render the respiratory function of the invagination, in this case at least, almost unquestionable.

These five arguments, I think, completely justify Croneberg in homologizing these organs with tracheæ. Further, in addition to these arguments in favour of their being tracheæ, we have the following arguments against their being connected with reproduction :—

(*f*) The entire absence of muscles renders it very improbable that they are transmitters of sperm.

(*g*) I could find no such close connection between their apertures and the median genital aperture as to warrant my thinking that sperm, on being discharged from the latter, would find its way up into these tubes.

(*h*) The only reproductive organs which it seems probable that they might be would be receptacula seminis, but they are said to be confined to the males.

Summing up these arguments, I think the balance of the evidence is in favour of their being tracheæ, and if their claim to serve as accessory reproductive organs is not altogether without foundation, yet, in the case described and figured in this paper, the function of the organs is clearly and exclusively respiratory; I say "exclusively" because respiration is a somewhat exclusive function, at least it certainly would not admit of the air-passages being choked up with sperm-cells.

It seems to me that we may here have to do with one of the simplest of all known tracheal invaginations,—a short blind chitinous tube, without highly specialized crenulations, and without specialized apparatus for the protection of the orifice. Some such chitinous invagination must have been the original starting-point of all the more specialized forms, the lung-books, tracheal tufts, and tracheæ. Further, the formation of the chambers, which appear to be chitin-lined spaces within the original secreting cells, seems to show how the different specializations of tracheæ arose. By the flattening of such chambers

one against another, the lung-books could easily be obtained; by the development of each chamber into a long intracellular tubule, the tracheal tuft; and by the development of one or two chambers into long tubes, the tubular tracheæ.

I therefore offer the suggestion that these ram's-horn invaginations opening under the genital operculum, in the Chernetidæ, may be the nearest approach to the primitive form of trachea yet discovered.

In the matter of tracheæ, then, the Chernetidæ are very important Arachnids, and throw a strong light on the origin of the whole group from some earlier ancestor, with a pair of limbs and a pair of tracheal invaginations on every trunk-segment. In the Chernetidæ all trace of the cephalothoracic tracheæ have vanished, unless we can homologize the coxal glands with tracheæ. But on the abdomen the first segment has occasionally a very primitive form of trachea, the two following segments have normal tuft-tracheæ, and the seven following segments seven pairs of vestigial stigmata!

#### *The Sensory Organs.*

The structure of the eyes, of which there are in *Obisium* two pairs, may be seen from the diagram (fig. 15). The lenses were not very compact, the layers of chitin showing, in section, a loose lamination which, if not due to the action of alcohol, must detract from their dioptric efficiency. The retinal cells were very large and seemed to be continued into rods, the distal ends of which were embedded in the pigment-cells forming the cup. I could not find out the connection between the nerve and these inverted retinal cells.

The cells secreting the lens form a very distinct layer, the vitreous body. This fact is interesting because the lateral eyes of *Scorpio*, which are apparently the homologues (or ? analogues) of these lateral eyes of *Obisium*, are said to have no such vitreous layer\*. This seems to show how very little value can be attached to the structure of eyes in questions of affinity.

Perhaps almost as important as the eyes are the sensory organs found in the arthrodial membranes between the thick chitinous ring at the edge of the coxa and the trochanter on the last two pairs of legs. The fine cuticle seems to project as a

\* Lankester and Bourne, "The Minute Structure of the Lateral and the Central Eyes of *Scorpio* and *Limulus*," Q. J. M. S. xxiii.

papilla or as papillæ, into which run at least two very large sensory cells (fig. 16). In addition to these cells, and near them, are found large ganglia composed of some twenty to thirty cells; their connections I was, however, unable to follow. These ganglia were very conspicuous in all four coxæ of the last two pairs of legs, but the long sensory cells I succeeded in finding only in one leg. I had not sufficient material to pursue the investigation further. All important sensory organs discovered on the legs of Arachnids are of interest as perhaps throwing light on the origin of the "raquets" of *Galeodes* and the "combs" of *Scorpio*.

Croneberg further describes a tubular sac, which he takes to be a gland opening at the tip of the movable joint of the pincers on the pedipalps. I have not succeeded in finding such a structure, but Croneberg's description reminds one of the invagination at the tip of the pedipalps of *Galeodes*, which is probably olfactory\*.

I have made no special observations on the nervous system.

#### *The Genital Glands.*

The general form of the female organ is already well known. The chief point of interest, morphologically, is the union of the paired ovaries to form, with the oviducts, the ring characteristic of so many Arachnids. There is no such fusion in *Galeodes*, which is probably in this respect primitive, while, on the other hand, there are many bridgings between the two glands in *Scorpio*, which is thus more specialized in regard to its reproductive system than any other Arachnid, except perhaps some Acarids. As a matter of fact, the genital glands seem to develop wherever they can, filling up the spaces left by the intestinal diverticula. We have a kind of struggle for existence between two organs in the same body, which, however, cannot from the nature of the case be a war of extermination, but rather an effort to attain the relative proportions most advantageous for the race.

My material was, unfortunately, quite insufficient to work out the problems connected with the sexual glands.

The arrangement of the sexual apparatus seemed to be somewhat complicated, although not so complicated as Croneberg

\* "On the Terminal Organ of the Pedipalp of *Galeodes*," Ann. & Mag. Nat. Hist., Jan. 1893.

described. He seems to have included the chitinous folds of the genital operculum, which greatly confused the sections, as parts of the sexual apparatus. This accounts for his considering the ram's-horn organs and the abdominal "spinning" glands as being directly connected with the sexual organs, whereas, if the above account is correct, all these are distinct—the ram's-horn organs are tracheæ without a specialized stigmatic opening, and protected by opening under the genital operculum, and the so-called spinning-glands open on median papillæ at the anterior edges of the 2nd and 3rd segments.

In fig. 11, sections of four out of six (eight?) glands appear, which open into, and overlie dorsally, a chitin-lined pocket, which, if the specimen be really a male, may be a seminal vesicle.

The morphological problems involved in the observations here described will be discussed still more fully in a general work on the morphology of the Arachnida, to be based on an account of the anatomy of *Galeodes*, which is already near completion.

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## EXPLANATION OF THE PLATES.

## PLATE XXXI.

- Fig. 1. The ventral abdominal surface of an unclassified *Obisium* (macerated in caustic potash), showing the stigmata on the 2nd and 3rd segments, and a pair of rudimentary stigmata on all the following segments in exactly corresponding positions. On the right, except in the anal and penultimate segments, these rudimentary stigmata are seen through the upper cuticle, the skin being folded. The hairs are not all drawn, but are indicated by their round points of insertion on the cuticle. There are no traces of openings of abdominal "spinning" glands.
- Fig. 1 *a*. One of the chelicerae of the same.
- Fig. 2. Macerated specimen from a bottle labelled *Obisium sylvaticum*. The stigmata are seen through the coxa of the last pair of legs. The segmentation at the anterior end of the abdomen is very difficult to ascertain. The hairs or their points of insertion are given only on the left side. The rudimentary stigmata are seen nearer the median line and nearer the middle of the segment than in fig. 1 (on this point *cf.* text, p. 422). The lateral membrane in this species is quite different from that represented in fig. 1. It is beset with minute papillae. The openings of the lateral infoldings corresponding with the diaphragm or waist of other Arachnids is seen (*i*) just anteriorly to the trochanter of the last pair of legs.
- Fig. 2 *a*. The chelicerae of the same, showing the fine spinning-ducts (*d*) and their openings.
- Fig. 3. One of the rudimentary stigmata from fig. 2 ( $\times 2000$ ). The black dots are fine refractive points in the cuticle.
- Fig. 4. Section through the rostrum, showing the labrum (*L*) folded down laterally, with the labium (*l*) fitting into it. Transverse muscles similar to those shown in the section occur in the labrum of *Scorpio* and of Araneids.
- Fig. 5. The movable lamellae on the coxa of the pedipalps and the paired (sensory?) prolongations of the labrum. The form of the labium can also be seen, reminding one of the median process between the pedipalps of *Phrynus*.
- Fig. 6. Diagram of the alimentary canal. Commencing at the rostrum *r* it swells into the sucking-apparatus *ss*, passes through the ganglionic mass *b*, to dilate immediately into a system of diverticula, of which 1 and 2 are paired and 3 is median and ventral. *o* represents the ovary (which is shaded), the paired oviducts of which embrace the median ventral diverticulum (3); *md*, muscle dissepiments between the secondary diverticula (*sd*) of the 2nd pair.
- Fig. 7. Section through the abdomen; *sd*, secondary diverticulum. The large digesting cells excreting between them streams of crystal-like bodies which look black by transmitted and white by reflected light. These bodies are seen mixing with the contents of the canal. The cells are full of food-globules. *f*. Layer of peritoneal cells, Bertkau's "fat-body." *hg*. The loop of the hind gut suspended in the median plane.

The uppermost coil leads into the stercoral pocket, and its epithelial cells are very irregular owing to their being highly vacuolated. *o.* Ovary.

- Fig. 8. Horizontal section from a specimen infected by bacteria. *b.* Nests of the parasite in the peritoneal cells. *md.* Muscle blood-passages as in fig. 6, but much distended with coagulated blood. Between the digesting cells, the crystal-like faecal bodies (*f.*) have accumulated instead of streaming out between the cells. *dv.* Dorso-ventral muscles in section.

#### PLATE XXXII.

- Fig. 9. Cross section of the cephalothorax to show the position and importance of the silk-glands (*sg*) which open through the ducts in the mandibles (*d*, fig. 2 *a*). *en.* Endosternite.
- Fig. 10. The openings of the abdominal "spinning" or cement-glands at the anterior edges of the 2nd and 3rd abdominal segments; *g.* The space under the genital operculum; *m*<sub>1</sub> and *m*<sub>2</sub>, muscles for elevating and depressing the papillæ.
- Fig. 11. Horizontal section; showing the character of the anterior (*s*<sub>1</sub>) and posterior (*s*<sub>2</sub>) abdominal "spinning" or cement-glands; *e*, their secreting epithelium; *t*<sub>3</sub>, portions of the ram's-horn organ; *c*, coxal glands; *m*, muscles from the endosternite to the 1st pair of legs, showing the position of the endosternite far back in the cephalothorax.
- Fig. 12. Ditto, diagrammatic; showing the arrangement of the tracheæ. *t*<sub>1</sub>. The posterior pair bent back by the enormous development of the spinning-glands; *t*<sub>2</sub>, the anterior pair, only short lengths of the intracellular tubules are shown; *t*<sub>3</sub>, the ram's-horn organ opening under the genital operculum (*g*); they are covered in the specimen with air-chambers; *i*, lateral infoldings of the body-wall.
- Fig. 12 *a.* Part of the ram's-horn organ with air-chambers, showing traces of protoplasm. The air-chambers are apparently intracellular.
- Fig. 13. Cross section of coxal gland, showing the nuclei and the striated appearance of its walls.
- Fig. 14. Left-hand coxal gland opening on the posterior face of the coxa of the 3rd leg, reconstructed from sections.
- Fig. 15. Section through the eye, the large retinal cells with their distal ends (rods?) embedded among the cells forming the pigment-cup.
- Fig. 16. Sensory cell in coxa of the 3rd leg. *ch.* Section of thick chitinous ring round the distal end of coxa, with secreting hypodermis. The sensory cell runs out into a fold of the arthrodial membrane between the coxa and trochanter.

Notes on British Tunicata.—Part II. By W. A. HERDMAN, D.Sc.,  
F.R.S., Professor of Natural History in University College,  
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[Read 15th June, 1893.]

(PLATES XXXIII.—XXXVI.)

DURING the Session of 1880 I laid before this Society the first part (dealing with the family Ascidiidæ) of a paper on British Tunicata, a group of animals which I had shortly before commenced to study systematically. I hoped at that time that further parts would have followed in rapid succession; but various circumstances, and chiefly my having undertaken the examination of the large 'Challenger' collection, prevented me from finishing any other families of the British forms; and it is only now, after the lapse of thirteen years, that I have a further instalment of notes ready. This part falls naturally into two sections:—(1) Some corrections of my former paper, and my views as to some other British species of Ascidiacea described long ago by Forbes, Alder and Hancock, and others; and (2) my notes on some of the British Cynthiidae.

#### I. ASCIDIIDÆ (Supplementary\*).

With the fuller knowledge I now have of variation in the Tunicata, and after the experience of the last thirteen years in examining specimens of the genus *Ascidia*, I am inclined to think that I laid too much stress upon minute structural characters in Part I., and described as new species several forms which it would be better to regard as varieties. I think that my *A. lata* may be merely the common *A. mentula*, although it differs from the usual form of that species in the small number (16 to 20) and size of the tentacles. The usual number of tentacles in *A. mentula* is about 60; but I have found only 16 in a specimen 8 cm. long, and Garstang has recorded 18; while Traustedt, on the other hand, gives 78 to 85 as the number in Mediterranean specimens.

My *A. fusiformis* may also be merely a variety of *A. mentula*; it has, however, a neater and more slender and fusiform shape, an unusually small number of stigmata in each mesh (three,

\* For former paper see Journ. Linn. Soc., Zool. vol. xv. p. 274.

while *A. mentula* has about five), while the tentacles are small and distant, 25 to 30 in number, and larger and smaller alternately. The *A. truncata* of Part I. may be a large, rough, and somewhat deformed variety of *A. aspersa*, O. F. Müller, perhaps the form described by Alder as *A. pustulosa*; my *A. triangularis*, on the other hand, is probably a small neat form of the same species (*A. aspersa*), corresponding to that described as *A. aculeata* by Alder. If one compares *A. truncata* and *A. triangularis*\* one with another, it seems almost absurd to regard them as one species; but viewed in the light of Alder's *A. pustulosa* and *A. aculeata*, and of various intermediate varieties I have found since, I have very little doubt that they are the extreme forms of a series which must be regarded as belonging to *Ascidiella aspersa*, O. F. Müller.

My *A. Patoni* may, I think, be referred to *A. venosa*. It agrees well with the species which Alder and Hancock called *venosa*, and which is usually called *venosa* now, in general appearance and in the simple condition of the branchial sac, which is quite exceptional amongst species of *Ascidia* in not being longitudinally plicated. I feel, however, somewhat doubtful whether this is really the *A. venosa* of the 'Zoologia Danica.' O. F. Müller's figure† and description show the atrial aperture as more than halfway down the body, while in the British specimens I have seen it is near the anterior end. The test also seems more flaccid and gelatinous in the northern form.

Finally, *A. exigua* of the former paper is probably the young of some other species, perhaps of *A. plebeia*; but I am not sure, as it appears to differ a little from all species known to me. I ought not to have described so small, and, as I now think, immature looking, a form as the type of a new species.

In regard to the other species referred to in Part I., I have nothing to alter; and I still hold to the relationships of the species and genera given there, except that I have since adopted the genus *Ascidiella* of Roule (1884) for those forms in which the nerve-ganglion and subneural gland are placed close to the dorsal tubercle. This genus includes the following British species: *A. venosa*, *A. virginea*, *A. aspersa*, and *A. scabra*, which can be readily distinguished as follows:—

\* See Part I., Linn. Journ. Zool. vol. xv. p. 280 *et seq.*, pls. xv. & xvi.

† Zool. Dan. tab. xxv.

- a.* Branchial sac with well-marked papillæ. *A. venosa*, O. F. M.  
*b.* No papillæ.  
 1. Dorsal lamina with plain margin . . . . *A. virginea*, O. F. M.  
 2. Dorsal lamina with margin more or less toothed.  
     *a.* Attached by small area, branchial lobes denticulated,  
         about 5 stigmata in mesh . . . . . *A. aspersa*, O. F. M.  
     *β.* Attached by whole left side, branchial lobes rounded,  
         from 7-12 stigmata in mesh . . . . *A. scabra*, O. F. M.

I have lately gone over carefully the descriptions and figures of Ascidians given by O. F. Müller in the 'Zoologia Danica;' and I believe it will be useful if I give here a list of his 20 species, putting opposite each what is now considered the proper name according to my judgment. It will be noticed that his 20 species of *Ascidia* become reduced to about 16 species, referable to 9 different genera and 4 families. Nearly all these forms are British.

*List of Ascidians in O. F. Müller's 'Zoologia Danica.'*

ASCIDIA.	
<i>A. mentula</i>	= <i>Ascidia mentula</i> , O. F. M.
<i>A. rustica</i>	= <i>Styela rustica</i> (L.).
<i>A. venosa</i>	=? present <i>Ascidiella venosa</i> ; or ? red soft variety of <i>A. mentula</i> .
<i>A. prunum</i>	=? <i>Ascidiella scabra</i> (O. F. M.).
<i>A. conchilega</i>	=? <i>Ascidia plebeia</i> ; ? <i>Polycarpa comata</i> ; or ? not British*.
<i>A. parallelogramma</i>	= <i>Corella parallelogramma</i> (O. F. M.).
<i>A. virginea</i>	= <i>Ascidiella virginea</i> (O. F. M.).
<i>A. canina</i>	= <i>Ciona canina</i> (O. F. M.), a var. of <i>C. intestinalis</i> (L.) [figs. 1-3 = <i>C. intestinalis</i> ].
<i>A. patula</i>	=? <i>Ascidiella aspersa</i> (O. F. M.); or ? not British.
<i>A. aspersa</i>	= <i>Ascidiella aspersa</i> (O. F. M.).
<i>A. scabra</i>	= <i>Ascidiella scabra</i> (O. F. M.).
<i>A. orbicularis</i>	=? <i>Ascidiella scabra</i> ; or ? not British.
<i>A. corrugata</i>	= <i>Ciona intestinalis</i> (L.).
<i>A. lepadiformis</i>	= <i>Clavelina lepadiformis</i> (O. F. M.).

\* It was re-described by Kupffer in 1875 as a *Phallusia* from Norwegian specimens, but is apparently not known to Traustedt.

## ASCIDIA.

- A. echinata* = *Cynthia echinata* (L.).  
*A. aggregata* = *Styela aggregata* (O. F. M.).  
*A. tubularis* = a Molgulid, possibly *Eugyra glutinans* (Möll.).  
*A. compressa* = *Ascidia compressa* (O. F. M.) [not British].  
*A. gelatina* = a *Clavelina*, probably *C. lepadiformis* (O. F. M.).  
*A. pyriformis* = *Rhabdocynthia papillosa* (L.).

Passing next to the species given by Prof. Edward Forbes in Forbes and Hanley's 'British Mollusca,' most of these are good species; but many of them have, with the progress of science, changed at least their generic names; hence the following list will probably be useful:—

In vol. i. p. 26 *et seq.*

- Clavelina lepadiformis*, O. F. M. = *C. lepadiformis* (O. F. M.).  
*Perophora Listeri*, Wieg. = *P. Listeri*, Wieg.  
*Ascidia intestinalis*, L. = *Ciona intestinalis* (L.).  
*A. canina*, O. F. M. = *Ciona intestinalis* (L.), var.  
*A. venosa*, O. F. M. = *Ascidiella venosa* (O. F. M.).  
*A. mentula*, O. F. M. = *Ascidia mentula*, O. F. M.  
*A. arachnoidea*, Fab. Requires further investigation  
 [? *Phallusia mammillata*].  
*A. scabra*, O. F. M. = *Ascidiella scabra* (O. F. M.).  
*A. virginea*, O. F. M. = *Ascidiella virginea* (O. F. M.).  
*A. parallelogramma*, O. F. M. = *Corella parallelogramma* (O. F. M.).  
*A. prunum*, O. F. M. = ? *A. scabra* (O. F. M.).  
*A. orbicularis*, O. F. M. = *A. scabra* (O. F. M.).  
*A. aspersa*, O. F. M. = *Ascidiella aspersa* (O. F. M.).  
*A. vitrea*, van Ben. = ? young of *A. virginea* (O. F. M.).  
*A. conchilega*, O. F. M. = a *Molgula*; requires further investigation.  
*A. echinata*, L. = *Cynthia echinata* (L.).  
*Molgula oculata*, Forb. = *M. oculata*, Forb.  
*M. tubulosa*, Rath. = *Eugyra glutinans* (Möll.).  
*Cynthia microcosmus*, Sav. Requires further investigation.  
*C. claudicans*, Sav. = ? *Cynthia squamulosa*, Ald.  
*C. tuberosa*, Macg. = *Polycarpa pomaria*, Sav.  
*C. quadrangularis*, Forb. = *Polycarpa quadrangularis* (F.).  
*C. informis*, Forb. = *Styela informis* (F.).

In vol. i. p. 26 *et seq.*

<i>Cynthia tessellata</i> , Forb. }	= <i>Forbesella tessellata</i> (Forb.).
<i>C. limacina</i> , Forb. }	
<i>C. morus</i> , Forb.	= <i>C. morus</i> , Forb.
<i>C. rustica</i> , Linn.	= (?) <i>Polycarpa glomerata</i> (Ald.).
<i>C. grossularia</i> , van Ben.	= <i>Styelopsis grossularia</i> (v. Ben.).
<i>C. ampulla</i> , Brug.	= <i>Polycarpa comata</i> (Ald.).
<i>C. mammillaris</i> , Pall.	Requires further investigation.
<i>C. aggregata</i> , Rath.	= <i>Styela aggregata</i> (Rath.).
<i>Pelonaia glabra</i> , F. & G. }	= <i>Pelonaia corrugata</i> , Forbes &
<i>P. corrugata</i> , F. & G. }	Goodsir.

SUPPLEMENTARY\* (in vol. ii. p. 372 *et seq.*).

<i>Ascidia sordida</i> , A. & H.	= <i>Ascidella virginea</i> (O. F. M.).
<i>A. albida</i> , A. & H.	= <i>A. scabra</i> (O. F. M.).
<i>A. depressa</i> , A. & H.	= <i>Ascidia depressa</i> (Ald.).
<i>A. elliptica</i> , A. & H.	= ? <i>A. scabra</i> (O. F. M.).
<i>A. pellucida</i> , A. & H.	Requires investigation.
<i>Molgula arenosa</i> , A. & H.	= <i>Eugyra glutinans</i> (Möll.).
<i>Cynthia coriacea</i> , A. & H.	= ? <i>Polycarpa pomaria</i> (Sav.).

In order to complete this review of the more important published lists of British Ascidiidæ, I shall now state what I know in regard to the numerous species of *Ascidia* described by Messrs. Alder and Hancock. Of these very short, in fact insufficient, descriptions without any figures were published in the 'Annals and Magazine of Natural History' by Alder in 1863, and by Alder and Hancock (after the death of the former) in 1870. Unfortunately, the detailed monograph of the British Tunicata which these investigators were known to be preparing for the Ray Society was interrupted by the death of first one and then the other of the authors; but it was understood that Albany Hancock had left a considerable amount of manuscript and drawings for the plates; and it is much to be regretted that that work, incomplete though it may have been, was not published. I do not know whether the MS. is still in existence. If so, it is strange that no one working at Ascidiæ has been allowed to see it, as it could scarcely fail to throw some light upon these species, many of which are so imperfectly known. Fortunately, Canon A. M. Norman has in his magnificent collection a number

\* This covers the species described by Alder in 1848 in Trans. Tynes. Nat. Field Club, vol. i.

of specimens of Ascidians named by Alder or Hancock; and he has most kindly allowed me to examine these, many of which are the original types. For this and for the loan of many other specimens for examination and comparison, I wish to express my hearty thanks to Canon Norman.

The following is a list, with the modern names, of the species described by Alder in 1863\* (omitting species already dealt with):—

<i>Ascidia pustulosa</i>	= <i>Ascidiella aspersa</i> (O. F. M.).
<i>Ascidia obliqua</i>	= <i>A. obliqua</i> , Ald.
<i>Ascidia rudis</i>	= ? <i>A. mentula</i> , O. F. M.
<i>Ascidia plebeia</i>	= <i>A. plebeia</i> (Ald.).
<i>Ascidia aculeata</i>	= <i>Ascidiella aspersa</i> (O. F. M.).
<i>Ascidia pulchella</i>	= <i>Ciona intestinalis</i> (L.), variety.
<i>Molgula socialis</i>	= <i>M. socialis</i> , Ald.
<i>Molgula arenosa</i>	= <i>Eugyra glutinans</i> (Möll.).
<i>Cynthia squamulosa</i>	= <i>C. squamulosa</i> , Ald.
<i>Cynthia rosea</i>	= ? <i>C. squamulosa</i> , Ald.
<i>Cynthia echinata</i>	= <i>C. echinata</i> (L.).
<i>Cynthia mammillaris</i>	= <i>Styela</i> sp. ?
<i>Cynthia sulcatula</i>	= <i>Styela</i> sp. ?
<i>Cynthia granulata</i>	= <i>Styela</i> sp. ?
<i>Cynthia comata</i>	= <i>Polycarpa comata</i> (Ald.).
<i>Cynthia glacialis</i>	= <i>Styela</i> sp. ?
<i>Cynthia opalina</i>	= ? <i>Styela</i> . [Canon Norman's specimens are a <i>Molgula</i> .]
<i>Cynthia violacea</i>	= ? a <i>Molgula</i> .
<i>Cynthia glomerata</i>	= <i>Polycarpa glomerata</i> (Ald.).
<i>Thylacium Normanii</i>	= <i>T. Normanii</i> , Ald.
<i>Thylacium variegatum</i>	= <i>T. variegatum</i> , Ald.
<i>Diazona hebridica</i>	= <i>Diazona violacea</i> , Sav.

Also nine species of Compound Ascidians.

I shall now deal with the new species described by Hancock in 1870†. Some of these species were described from specimens in the collection of Canon Norman, who has, as I have stated above, very kindly allowed me lately to examine the type specimens and take notes from them. This has enabled me to come

\* Ann. & Mag. Nat. Hist. ser. 3, vol. xi. p. 153.

† Op. cit. ser. 4, vol. vi. p. 353, "On the Larval State of *Molgula*, &c."



to some definite conclusion in regard to several of Alder and Hancock's species. Others, from the condition of the only specimens, cannot now be satisfactorily determined or characterized.

1. *A. plana*, Hnk.—I have seen no specimen of this. From Hancock's short description I do not see how it can be distinguished from a small *A. mentula*.

2. *A. Alderi*, Hnk.—I would say the same in regard to this. The characters Hancock relied upon to distinguish these two species are liable to great individual variation.

3. *A. rubrotincta*, Hnk.—I have seen Canon Norman's type specimen of this, obtained by him between tide-marks at Guernsey in 1865. It measures 6 cm. by 3 cm., and is of elongated elliptic form, with both ends about equally rounded; the branchial aperture is anterior, and the atrial is more than halfway down the dorsal edge and does not project so much as in a typical *A. mentula*. It had been attached to a shell by the middle of the left side; but no stress can be laid upon the mode of attachment in these forms, as it is probably to a large extent accidental.

The test is cartilaginous, but flexible and not thick; vessels are readily visible. The mantle is very muscular on the right side. The branchial sac is plicated. There are very large papillæ on the bars. The meshes are elongated transversely.

The tentacles are numerous, slender, and of three sizes.

The dorsal lamina is ribbed transversely.

The dorsal tubercle is rather small, and roughly of triangular shape; the aperture is anterior, and both horns are turned in.

The alimentary canal occupies the posterior two thirds of the left side.

Hancock admitted that this is closely allied to *A. mentula*; and with the greater knowledge we now have of variation in these forms, it is, I believe, impossible to separate the two. Colour is of no importance; and the other points of difference Hancock mentions are too slight to rely upon.

I have found specimens adhering to stones and seaweeds a few feet below low-water of spring tides at East Loch Tarbert, Loch Fyne, which agree well with Hancock's description of *A. rubrotincta*, and which were associated with *A. mentula*, and were evidently the same species.

4. *A. rubicunda*, Hnk.—I have examined Canon Norman's type specimens from the Hebrides and from Strangford Lough. One

of those in the bottle seems to me to be *Ascididiella venosa*; the others I cannot distinguish from *Ascidia mentula*. Hancock gives as a character separating this form from *A. mentula* that it is more extensively attached, "adhering by the whole side;" but one at least of the type specimens is only slightly attached by the posterior end. The fact is that amongst specimens which I have collected at East Loch Tarbert, and which I at once referred to Hancock's "*rubicunda*," it is easy to find individuals in all conditions of attachment—some are merely clinging slightly by some one point to the edge of a stone or a *Laminaria* "root," or a piece of broken crockery, others lie flat along, and are attached by the whole surface, or, if in a crevice, even by both surfaces. I need not go over in detail the notes I have taken from Canon Norman's specimens and from my own Tarbert ones. They show a general agreement with *A. mentula* along with considerable individual variation. (See also below, p. 442.)

5. *A. robusta*, Hnk.—I have examined Canon Norman's type specimens of this from Herm; but unfortunately some of them are merely empty tests, and the others are in bad condition, so I was unable to make out the characters very satisfactorily. It may be that, as Garstang suggests, this species is a form of *A. mentula*. I have found, amongst the specimens agreeing with Hancock's *A. rubicunda* from East Loch Tarbert, some growing amongst *Laminaria* "roots" which agree in external characters with this form. On the other hand, when examining Canon Norman's specimens, I was distinctly reminded by them of Alder's *Ascidia depressa*; and some young specimens labelled "from Guernsey, named by Hancock," are very like young *A. depressa*. These young specimens are also not unlike the specimens of *A. producta*, Hnk., which I have examined. As Ascidians continue to grow and change in appearance long after they have commenced to reproduce, and so can be sexually mature without being full grown, it is often very difficult to correlate younger and older forms of the same species; and there must constantly be cases of doubt until the various species have been reared in aquaria and the same individuals have been drawn at various ages.

6. *A. mollis*, Ald. & H.—I have not seen any specimens of this species; but Mr. Garstang\* has found some at the Isle of Wight

\* Journ. Mar. Biol. Assoc. n. s. vol. ii. no. 2, p. 119.

which he considers to belong to Alder and Hancock's species, and of which he has given lately a full description.

7. *A. crassa*, Hnk.—I have examined Canon Norman's type specimens collected at Jersey in 1869. I think this is a good species; and to Hancock's description\* I shall merely add a few notes and some figures from the specimens (see Pl. XXXIV. figs. 7–10).

The branchial and atrial apertures are perfectly sessile and inconspicuous. The test is thick, solid, cartilaginous, and stiff; vessels are present. The mantle is strong and muscular on the right side (Pl. XXXIV. fig. 10) and along the dorsad edge. The branchial sac is notable for the very stout papillæ, which are of two sizes, it is true; but both kinds are so large that they nearly touch at their bases, and practically all the space on the bar between two main papillæ is taken up by the intermediate one (Pl. XXXIV. fig. 9).

The tentacles are numerous and irregular in size. They seem more numerous and densely crowded at the dorsal and ventral edges, and both smaller and fewer at the sides.

The dorsal tubercle is large and of rounded outline; the aperture is anterior, and both horns are turned in, one being long and curved (fig. 8).

8. *A. inornata*, Hnk.—I have not seen any specimens of this species. From the description it seems certainly, as Hancock himself says, rather like Alder's *A. plebeia*; and I do not see that the characters of the branchial papillæ and dorsal lamina establish any real distinction between the two species.

9. *A. producta*, Hnk.—I have examined Canon Norman's type specimens dredged in the Minch in 1866. This species is certainly closely allied to *A. plebeia*, and the smaller (younger) specimens are very like that species; but still I think *A. producta* may be regarded as a distinct species. I have found specimens on stones in East Loch Tarbert below extreme low tide which I refer to this species.

To Hancock's description I would merely add the following remarks (see Pl. XXXV. figs. 1–7):—The test seems to me rather soft and flexible (even in Canon Norman's spirit specimens) and thin, especially on the under surface. The mantle is very thin and is not very muscular, the muscles being, in fact, scarcely visible

\* Ann. & Mag. Nat. Hist. 1870, p. 359.

to the eye even on the right side; the branchial siphon is of extreme length. The prebranchial zone is papillated (Pl. XXXV. fig. 7). The tentacles are very numerous and closely placed. They are alternately large and small, and there are about 60 of each. The dorsal tubercle is large and of ovate form, the aperture is anterior, and the horns are irregular, and may even fork (see figs. 4, 5).

The renal vesicles are exceedingly abundant, and are filled with yellow and brown concretions (Pl. XXXV. fig. 2). They are scattered over the wall of the stomach and intestine, and even encroach upon the mantle.

I do not think that the specimens from Marseilles referred to *A. producta* by Roule\* belong to this species. As one distinction, the dorsal tubercle is of an entirely different type in Roule's species.

10. *A. elongata*, A. & H.—I have seen no specimens of this species. I would suggest—but I am judging from Hancock's short description alone—that the single specimen from Seaham Harbour might be an elongated example of *Ascidella aspersa* (O. F. Müller).

11. *A. affinis*, A. & H.—I have examined Canon Norman's type specimens, obtained by Dr. Baird in the River Roach, Essex, in 1865, and I am of opinion that they are very like overgrown flabby individuals of *Ascidella virginea* (O. F. M.). I have seen large specimens of what Alder and Hancock called "*A. sordida*" (which is *A. virginea*) from the Firth of Forth which were like the present form. Pedunculated individuals also, such as some of these *affinis*, are found in *A. virginea*†. On the other hand, the tentacles and dorsal tubercle in Canon Norman's specimens remind me more of *A. aspersa*; but these are very variable organs.

12. *A. Normani*, A. & H.—I have seen what is left of the type specimen, collected by Canon Norman between tide-marks in Strangford Lough in 1869; but unfortunately the specimen had evidently at some former time dried up, and nothing can now be made out from it except the shape and a thin membranous, almost leathery, test.

\* Ann. Mus. Marseilles, t. ii. Mém. 1.

† I described one as variety *pedunculata* in Trans. Roy. Soc. Edinb. vol. xxxii. part i. p. 98.

Hancock's description of this species reminds me strongly of the rather handsome specimens of *Ascidella aspersa* (*aculeata* form) which are found in some parts of the Clyde district, *e. g.* Lamlash Bay, and of which I give a figure (Pl. XXXIV. fig. 1); there is nothing in the appearance of Canon Norman's specimen to contradict the supposition that "*A. Normani*" may be *A. aspersa* (O. F. M.).

13. *Ciona fascicularis*, Hnk.—I have examined Canon Norman's type specimens, collected by Mr. A. G. More in Kilkieran Bay, Connemara; and there is no doubt that this is a good and well-marked species. I now give some figures (see Pl. XXXIII.) of the external appearance and internal structure, and the following notes to supplement Hancock's description.

The test has distinctly two regions (Pl. XXXIII. figs. 1 & 2)—the enlarged part at the posterior end, which is much firmer and is roughened on the surface, and the remainder, over the greater part of the body and anterior end, which is all very thin and membranous.

The union of individuals into clumps is effected entirely by the interlocking of little papillose outgrowths from the test round the posterior ends and a little way up the sides (Pl. XXXIII. figs. 2 & 3).

The mantle is thin and transparent, but has the strong longitudinal muscle-bands characteristic of the genus. The atrial siphon is completely dorsal in position and at right angles to the branchial. There is a long narrow pedicle connecting the anterior part of the branchial sac with the visceral mass (Pl. XXXIII. fig. 5) so as to divide the body into "thorax" and "abdomen;" but the branchial sac really extends down (though very narrow) to the level of the stomach. The vessels of the branchial sac are all very delicate. Papillæ, and sometimes intermediate papillæ, are present. The stigmata are very wide, and are about 4 in a mesh (Pl. XXXIII. fig. 4).

The tentacles are numerous, slender, about 50 of various sizes placed irregularly, but very closely (Pl. XXXIII. fig. 8).

The dorsal languets are triangular, small, broad, and flattened antero-posteriorly.

The dorsal tubercle is irregularly elliptical in shape, and is elongated transversely, with the aperture anterior and both horns turned in.

The œsophagus is very slender, the stomach pyriform, and the intestine large. Figures 6 and 7 show the curves of the alimentary canal.

The remaining species dealt with by Hancock in this paper are as follows—they are, I believe, all good species:—

<i>Corella larvæformis</i> , Hnk.	= <i>C. larvæformis</i> , Hnk.
<i>C. ovata</i> , Hnk.	= <i>C. ovata</i> , Hnk.
<i>Molgula simplex</i> , A. & H.	= <i>M. simplex</i> , A. & H.
<i>M. inconspicua</i> , A. & H.	= ? a <i>Ctenicella</i> .
<i>M. complanata</i> , A. & H.	= <i>Ctenicella complanata</i> (A. & H.).
<i>Eugyra globosa</i> , Hnk.	= <i>E. globosa</i> , Hnk.

It will thus be seen that several of Alder and Hancock's species of *Ascidia* are merely forms of *Ascidia mentula*, and it is a question whether we can recognize them as named varieties.

I have for some years thought it extremely probable that Hancock's *Ascidia rubicunda* and *A. rubrotincta* at least, and possibly other species in addition, were merely varieties of the well-known *A. mentula*, and in my "Revised Classification of the Tunicata,"\* I placed these amongst other species in a list of doubtful forms. Roule †, I believe, was the first to actually place *rubicunda* and *rubrotincta* definitely as synonyms of *mentula*; and Garstang ‡ has lately supported the same conclusion by the examination of some specimens from the Isle of Wight, which agree with "*rubicunda*" in form and with "*mentula*" in colour. I am not prepared to accept Garstang's classification of the varieties of *mentula*. It seems to me (and I am influenced chiefly by having found at Tarbert, Loch Fyne, specimens of all varieties of colour, from pale grey and brown to a gorgeous red, living together near low-water mark and mostly attached by an extensive area of the left side) that the "erect" or "depressed" condition is of more importance than the red or pale coloration; so I would be inclined to suppress "*ruberrima*," "*rubrotincta*," and "*rava*," but retain "*erecta*" and "*depressa*" as varieties §. However, it must be remembered

\* Journ. Linn. Soc., Zool. vol. xiii.

† Ann. Mus. Marseilles, t. ii. Mém. i. 1884.

‡ Journ. Mar. Biol. Assoc. n. s. vol. ii. p. 119.

§ Garstang, *l.c.* p. 138.

that there are really intermediate conditions between all of these named forms.

I have lately picked out three specimens of the typical *A. mentula*, dredged from deep water (30–40 faths.) in Loch Fyne, and three of the form which I regard as Hancock's *A. rubicunda*, collected from stones just below low-water mark in East Loch Tarbert, and have compared them carefully, with the result that although one can tell the dredged from the shore specimens by the lighter grey colour and the slightly more delicate mantle and branchial sac, still there is no structural difference that I can find in any part of the body, and not even a difference in degree that can be expressed in words and relied upon. Consequently I am confirmed in my opinion that these are merely two forms of the same species.

While making this comparison, I have had a useful lesson in regard to the variability in number of the tentacles, and have had my confidence in the published records of their numbers a little shaken by the following observation. Miss J. H. Willmer (whose kind assistance in my laboratory in examining many of these Ascidians I gratefully acknowledge) and I were noting the characters of the above-mentioned six specimens of *A. mentula*, and as they were all large (over five inches in length) and the tentacles seemed clearly visible to the eye, we merely turned these organs over one by one with a needle in counting them, and noted the results in numbers varying from 18 to 24. The appearance of one example, however, made us suspect that more tentacles were really present, and on dissecting out the region and getting it in a good light under the microscope we found that what had been visible before were only the more prominent ones, and that from 70 to 80 tentacles were really present. It was the same with the other specimens, all had over 60, some nearly 100 tentacles. In the published records by Heller, Traustedt, Garstang, myself, and others the numbers vary from 16 to 100, which does seem an extraordinary range; and I am tempted to suspect that I and others in the past may have been deceived by a few of the tentacles being very conspicuous when in reality many others may have been present in addition.

## Family CYNTHIIDÆ.\*

## Subfamily STYELINÆ.

POLYCARPA GLOMERATA (*Alder*). (Pl. XXXV. figs. 8-13.)

This species is probably very abundant on various parts of our coast, but has often, I think, been regarded as *Styela rustica*, or *Stylopsis grossularia*; it is, however, perfectly distinct from both. This is a gregarious form like *Polycarpa aggregata*, and although the tests of neighbouring individuals may fuse so as to form a continuous basal expansion or common test (see Pl. XXXV. fig. 8), still there is no further organic connection between the individuals; there are no common vessels and no buds are produced, consequently no true colony is formed, and the masses, which may be yards in extent, are merely aggregations of individuals adhering together.

There is a huge cavern near Spanish Head, at the south end of the Isle of Man, which can be entered in a boat at low tide, and its walls and part of the roof are covered by a continuous layer of this Ascidian. The individuals are of all sizes from a small pin's head up to nearly an inch across, they are of a rich crimson-red colour, and when touched they emit the usual jets of water forcibly and in all directions. Hence they are known locally as the "red-currant squirts of the sugar-loaf cave."

Good descriptions of this species have been given by Heller †, Traustedt ‡, and by Roule §, so there is no need to go over the characters in detail. The chief points which distinguish it from other British Styelinæ with which it might be confused are:—the agglomerated condition, the brilliant colour, the presence of more than one (usually 3) fold on each side of the branchial sac, and the condition of the reproductive organs—broken up into numerous polycarps each of which is of one sex only.

I find that this is one of those interesting species in which tentacles are present at the base of the atrial as well as of the branchial siphon. They are very numerous but minute (Pl. XXXV. fig. 10). In regard to their possible function, I

\* For the characters of the family and subfamily see Herdman's "Revised Classification of the Tunicata," Journ. Linn. Soc., Zool. vol. xxiii. p. 569.

† Untersuch. u. d. Tunicaten d. Adriat. u. Mittelmeeres, iii. Abth. p. 263 (1877).

‡ Mitth. a. d. Zoolog. Stat. zu Neapel, t. iv.

§ "Recherches sur les Ascidies Simples des Côtes de Provence," Biblioth. de l'École des Hautes Études, t. xxxi. art. no. 8, p. 150 (1885).



communicated a note at the last meeting of the British Association (Edinburgh) somewhat as follows :—

In the interesting paper ('Bulletin Scientifique,' July 1892) by Dr. C. Julin, which forms the first part of his 'Les Ascidiens des Côtes du Boulonnais,' I notice it is stated, on page 30, "L'existence d'une couronne de tentacules circumcloacaux n'a jamais, à ma connaissance du moins, été signalée chez aucune espèce d'ascidien simple ou composé." If it has escaped Julin's attention that I described and figured atrial tentacles in 1882 in a simple ascidian, and in 1886 in a compound one, then I fear it may have escaped notice altogether, perhaps because, along with some other anatomical observations and some theoretical conclusions and suggestions, it is buried in the 'Challenger' reports in a mass of detailed descriptions of new species. At any rate, the existence of atrial tentacles is evidently so little known that the following brief notes upon what I have seen of them may be of interest.

In the simple ascidian *Bathyoncus mirabilis* from the Southern Ocean, at a depth of 1600 fathoms, there are two circlelets of minute tentacular processes which project from the inner surface of the cloacal wall close to the atrial aperture. These atrial tentacles are all of the same size, and are placed at about their own length apart (see 'Rep. Tun. Chall. Exp.' part 1, vol. vi., 1882, page 167, and pl. xxiv. fig. 12, *at.t.*).

The ascidiozooids of the compound (?) ascidian, *Goodsiria placenta*, from the Cape of Good Hope, have also atrial tentacles, very much like those of *Bathyoncus mirabilis*, but forming a single series. In the original description (*op. cit.* part 2, vol. xiv. 1886, page 331, and pl. xliii. fig. 10) I wrote as follows : "At the base of the atrial siphon, where the invaginated layer of test ends, there is a slight ridge which bears a series of small tentacles projecting freely into the peribranchial cavity. These atrial tentacles are much smaller than the ordinary or branchial tentacles, and there are only twelve of them. The position of the atrial tentacles in relation to the atrial siphon corresponds exactly to the position of the branchial tentacles at the base of the branchial siphon, but their use at the entrance to the peribranchial cavity is not obvious. It has been observed in some simple ascidians that the current of water which usually flows in at the branchial aperture and out at the atrial is occasionally reversed for a short period, the atrial aperture becoming inhalent. Possibly in the present species this habit may have become so

marked as to have favoured the development of a circle of atrial tentacles, which would act as tactile organs waving in the current of water entering the animal."

During the last few years I have found similar atrial tentacles in at least three new species of the compound (?) ascidian genus *Chorizocormus*, viz., *Ch. sydneyensis*, *Ch. leucophæus*, and *Ch. subfuscus*, all from Australia. In each case they form a single circlet, as in *Goodsiria placenta*, and there are about twenty tentacles. They are briefly referred to in my "Revised Classification of the Tunicata" (1891), at page 636, and will be figured in the forthcoming 'Catalogue of Tunicata in the Australian Museum.' Julin has made the interesting discovery that atrial tentacles are also present in *Styelopsis grossularia*. I have likewise found them in that form, and now I can add *Polycarpa glomerata* to the list of species in which it is known that the organs are present.

I have queried above the genera *Goodsiria* and *Chorizocormus* as being compound ascidians because they belong to the family Polystyelidæ, in regard to which it must be considered still doubtful whether the masses of ascidiozooids are true colonies. But although they may be colonial forms now, there can be no doubt that phylogenetically the Polystyelidæ are closely related to the subfamily Styelinæ of the Cynthiidæ, the subfamily to which *Bathyoncus*, *Polycarpa*, and *Styelopsis* all belong. So we arrive at the interesting conclusion that the five genera in which up to now atrial tentacles have been noticed, although differing widely from one another in appearance, structure, and habitat, are yet phylogenetically rather closely related. I think it not unlikely that atrial tentacles will be found, if looked for, in other members of the groups Styelinæ and Polystyelidæ.

Another point: it is an interesting fact, and may have some significance, that—putting aside *Bathyoncus mirabilis*, in regard to the conditions of life of which we know nothing—all the six other species in which atrial tentacles have as yet been demonstrated form either colonies or aggregations, i.e. they have numbers of small individuals or ascidiozooids massed together. It is quite conceivable that, under these crowded conditions, it may be some advantage to the animals to have the power (to return to the suggestion I made in the 'Challenger' Report) of frequently reversing the current of water or of using the atrial for a time as the inhalent aperture—possibly, for example, because of being so placed amongst neighbours that the atrial siphon is able to

draw upon a purer supply of water—and in any such case the advantage of having the entrance to the peribranchial cavity provided with a circlet of tentacles is obvious.

I find the branchial sac in *Polycarpa glomerata* liable to very considerable individual variation, and in figs. 11, 12, 13 on Plate XXXV. I give the graphic branchial formula\* of three individuals. From these it will be seen that the number of folds may be four on each side, four on one side and three on the other, or three on each side; sometimes there are less than three folds. Usually one fold (or more) on each side is rudimentary, *i. e.* is really no longer a fold, and does not project into the cavity of the sac, and in such cases it is only possible to recognize the position of the missing or reduced fold by the approximation of the internal longitudinal bars (see Pl. XXXV. fig. 11; right side IV., left side I.).

The dorsal tubercle is crescentic, and lies obliquely in a shallow peritubercular area (Pl. XXXV. fig. 9).

POLYCARPA QUADRANGULARIS (*Forbes*). (Pl. XXXVI. figs. 11, 12.)

*Cynthia quadrangularis*, *Forb.*, *British Mollusca*, vol. i. p. 38, pl. D. fig. 1.

This species was described by Forbes in 1853 from specimens dredged by Mr. R. McAndrew and himself from a depth of 30 fathoms in Loch Fyne. So far as I am aware it has not been recorded since, although I find a specimen of it, also from Loch Fyne, amongst the *Cynthiidae* of Canon Norman's collection. I dredged in September 1892 a *Polycarpa* from a depth of 80 fathoms, in Loch Fyne between Tarbert and Ardrishaig, which corresponds so closely with Forbes's figure in the 'British Mollusca' and with his short description that I am convinced that it is the *quadrangularis*, and I am pleased to be able to restore Forbes's species, and give the following sufficient anatomical description of it drawn up from an examination of a specimen hailing from the original locality.

A most marked feature in the external appearance is the pair of long siphons, each of which is quadrangular in section and has the large square aperture on its summit. The apertures fold into an X shape in closing.

\* For the explanation of this brief method of expressing the condition of the folds, bars, and stigmata of the branchial sac, see Herdman, "On individual variation among Ascidians," *Proc. Lit. and Phil. Soc. Liverpool*, vol. xxxvi. p. 313 (1882).

The test is tough and leathery, rather thin, wrinkled on the outside, and smooth and glistening on the inside.

The mantle is very thick and muscular, and of a light grey colour.

The branchial sac is large, with four large folds on each side. There are from three to six bars between two folds, and eight or nine on a fold. Meshes are either square or transversely elongated, with four to eight straight stigmata (Pl. XXXVI. fig. 11).

The dorsal lamina is a plain membrane transversely ribbed.

The tentacles are simple, about 30 in number and of different sizes.

The dorsal tubercle is large and somewhat cordate. It is placed in a deep triangular peritubercular area; one horn is much turned in (Pl. XXXVI. fig. 12).

The stomach is longitudinally folded.

The reproductive organs are in the form of numerous scattered polycarps over the inner surface of the mantle.

#### “*STYELA RUSTICA* (L.).”

There has been much confusion in regard to this species in our seas, and although various authors (from Forbes down to myself) have named British specimens “*Cynthia rustica*,” “*Styela rustica*,” or “*Polycarpa rustica*,” I am now inclined to think that none of these are referable to Linnæus’s *Ascidia rustica*, which is a Northern species probably not inhabiting the British area at all.

I think that what I at least have mistaken in the past for small specimens of *Styela rustica* were really solitary individuals of *Polycarpa glomerata*, which are sometimes found attached to the “roots” of *Laminaria*; and I first suspected that something was wrong when I found that, from the structure of the reproductive organs, my supposed “*rustica*” was really a *Polycarpa*, not a *Styela*, and I pointed this circumstance out in my Report on the L. M. B. C. Tunicata\*. Then I put the matter beyond doubt, so far as my own case was concerned, by dredging large quantities of the true *Styela rustica*, of all sizes from a pea up to 2 inches across, along with the closely allied form *Styela monoceros*, to the north of the North Cape, Norway, in July 1891. The examination of this large series of specimens showed (1) that *rustica* is a *Styela*, and (2) that it is quite distinct from any form I have met with in British seas. Subsequently Canon Norman kindly sent me his specimens of *Styela rustica* from

\* Fauna of Liverpool Bay, vol. i. 1886.

Greenland ('Valorous' Expedition) to examine, and I found that they were the same as my own Norwegian forms.

In regard to the supposed identity of *Styela rustica*, Linn., and *St. monoceros*, Müller, I have the following remarks in my notes made during the examination of my Norwegian collections:—

These two closely allied forms are characteristically northern, and we obtained immense numbers of them on July 11th when dredging near the North Cape at depths of 75 to 150 fathoms. They were of all sizes from little rounded ones like peas up to cylinders 5 cm. in length and 3 cm. in diameter. Many of them were attached together in groups of a dozen or more, and most of the larger ones had small ones growing on their tests. In colour they varied from grey and pale yellow to rich orange and brown. The edges of the siphons were generally of a brilliant scarlet tint. Good coloured figures of both these forms are given by Wagner in his 'Wirbellosen Thiere des Weissen Meeres.' Both Traustedt and Wagner, who have recently written on these forms, consider that they are one species, and that *monoceros* is merely *rustica* with a spine on the test; but after a careful examination of a large number of specimens of both *rustica* and *monoceros*, I am of opinion that there are constant characters in addition to the spine which can be relied upon to distinguish the two forms, and that therefore they may be regarded as distinct species. I have drawn up the following descriptions from the North Cape specimens.

*STYELA RUSTICA* (L.). (Pl. XXXVI. fig. 1.)

*External appearance.* Shape cylindrical to ovate, with the longer axis antero-posterior, not compressed laterally; attached by the wide posterior end. Dorsal and ventral edges nearly straight. Branchial aperture nearly or quite terminal; atrial on the dorsal edge, or slightly on the right side, nearly one third of the way down: both square. Surface slightly roughened, especially at the posterior end. Colour when alive pale yellow to dark red; in spirit dirty yellowish brown.

Length 3-4 centim., breadth 1.5-2 centim.

*Test* not specially thick, but tough and leathery; whitish on section and on the inner surface, where it is glistening—not adhering very firmly to mantle.

*Mantle* muscular and opaque. The external muscle-bands run circularly and the internal longitudinally; they do not form a complete coating. Many endocarps projecting from the

inner surface of the mantle. In some cases a good deal of opaque white pigment present.

*Branchial sac* with four folds on each side. The two dorsalmost folds larger than the others. There are from 6 to 12 bars on a fold and 3 or 4 in the interspace between two folds. The meshes are always elongated transversely, and contain from 6 to 20 long narrow stigmata. The meshes are generally divided by a delicate horizontal membrane. The transverse vessels are of three sizes, regularly arranged.

*Endostyle* large and conspicuous.

*Dorsal lamina* is a plain membrane with transverse ribs but no teeth upon the margin.

*Tentacles* simple, 20 to 30 in number, rather large and stout, alternately larger and smaller, sometimes with a number of very small ones in addition.

*Dorsal tubercle* prominent, large, and simple, with the aperture turned to the left side and the horns slightly turned in.

*The alimentary canal* is large; the stomach is long and is longitudinally folded.

*The gonads* consist of a dorso-ventrally running undulating tube with four or five branches directed anteriorly (Plate XXXVI. fig. 1). The duct runs posteriorly from near the dorsal end of the main tube. There are a number of endocarps scattered around the gonads and between their branches. This condition of the reproductive organs is very different in appearance from that of *Styela monoceros* (see Plate XXXVI. figs. 1 and 2), and by this character the two species can be distinguished at a glance when the mantle has been cut open and its inner surface exposed.

STYELA MONOCEROS (Möller). (Pl. XXXVI. fig. 2.)

*External appearance.* Elongate elliptical, not compressed laterally, attached by the base and a little way up the ventral side. The anterior end is marked by a curious spine-like projection composed of a solid outgrowth of test; it is situated midway between the branchial and atrial apertures. The branchial aperture is rather prominent and conspicuous, almost terminal, but inclining a little more towards the ventral edge; the atrial is smaller and less conspicuous, placed a little way down the dorsal side. The surface is considerably creased and roughened, in some specimens a good deal covered with zoophytes, shells, and other foreign matter. Colour dirty greyish yellow.

*Test* thin, but tough and leathery, whitish on section; inner surface smooth and shining, adhering rather firmly to the mantle.

*Mantle* very muscular, thick, and opaque. The external muscle-bands run circularly and the internal ones longitudinally, forming a complete coating. Numerous endocarps project from the inner surface of the mantle.

*Branchial sac* with four folds on each side, the two dorsalmost distinctly larger than the rest. On each fold there are from 12 to 14 bars, and from 10 to 12 in the interspaces. The meshes are small and nearly square, containing from 3 to 10 narrow stigmata, and most frequently divided by a narrow horizontal membrane. The transverse vessels are of three sizes.

*The dorsal lamina* is a plain membrane with transverse ribs.

*The tentacles* simple, about 16, some very large, but varying much in size and length.

*Dorsal tubercle* prominent, almost circular in outline, the horns slightly curled inwards, opening occasionally anteriorly, but more often to the left side.

*Endostyle* very broad, and considerably convoluted for a portion of its length, sometimes for the whole distance.

*The gonads* consist of one or two convoluted tubes on each side, with two or three very short branches, if any, and with the duct at the anterior extremity of the main tube and directed anteriorly (see Pl. XXXVI. fig. 2).

#### Subfamily CYNTHINÆ.

FORBESELLA TESSELLATA (*Forbes*). (Pl. XXXVI. figs. 3-10.)

A number of specimens dredged lately off the west of the Isle of Man, about 9 miles off Contrary Head, depth 46 fathoms, have enabled me to make a careful re-examination of this species. The specimens are mostly attached to dead shells of *Pecten maximus*, and they present a very great range of variation in shape, colour, texture, and general appearance—so much so that at first I was under the impression that I had before me two or three species; and now I can see that forms corresponding to Forbes's two species *Cynthia tessellata* and *C. limacina* are represented in the series, and that it would be possible to pick out and describe even more divergent specimens (see Pl. XXXVI. figs. 3-7).

In regard to shape, the typical form is like half a small walnut, but some are hemispherical while others are nearly quite flat, the

antero-posterior length (from the branchial aperture to the area of attachment) being very slight indeed compared with the extent in other directions. Around the edge of the area of attachment there is a thin margin or expansion, which is in some cases narrow and in others very wide (see figs. 3 & 5). The surface may be rough and corrugated or quite even; and I could not see that this difference was the result of the state of contraction of the animal, as I had about fifty specimens alive for a couple of days in my tanks at the Port Erin Biological Station, and the corrugated ones did not seem to fill out, although the branchial and atrial apertures were open. Even the characteristic polygonal scale-like markings on the surface of the test are much more distinct in some individuals than in others, and may be emphasized by touches of rose-red upon each scale so as to form a series of lines of spots (see fig. 7).

The colour of the living animal is generally of a reddish-purple tint, but it may be rose-red or grey with rosy marks, or it may be light yellow to yellowish brown, or finally of a dark purple. The specimens are, on the average, about 1.5 cm. in length.

The test is tough, although not thick except at the margins of the base. It is white on section and glistening on the inner surface, in places tinged with violet-red, which is specially marked at the branchial and atrial apertures.

The mantle is fairly muscular, and has a serrated projecting fold or partial diaphragm at the base of the atrial siphon, just in the position occupied by the atrial tentacles in *Polycarpa glomerata* and other forms.

The branchial sac has four well-marked folds on each side. The internal longitudinal bars are narrow and ribbon-like. There may be as many as 11 between two adjacent folds, or as few as 4, more usually there are 7 to 9. The meshes are square and contain about 4 large regular stigmata each (Pl. XXXVI. fig. 8).

The dorsal tubercle is nearly circular in outline. The horns are simply turned towards one another and are not bent (Pl. XXXVI. fig. 9).

The dorsal languets are very long and slender (Pl. XXXVI. fig. 9), and are more numerous than the transverse vessels; there are from 40 to 60 of them.

The tentacles are compound and of two very different sizes; there are about twenty of each. The stems of the larger ones are much inflated (see Pl. XXXVI. fig. 9).



OBS.—The remaining Cynthiidæ and the Molgulidæ, as well as a few Ascidiidæ, must be left over for a further instalment of these "Notes." Perhaps it ought to be stated that the coloured drawings of the species, which were exhibited when this paper was read, are reserved for my detailed monograph of the entire group which is now in progress.

NOTE.—Since this paper was in type I have received, thanks to the courtesy of the authors, a copy of the beautiful Monograph by MM. Lacaze-Duthiers and Yves Delage, entitled "Faune de Cynthiades de Roscoff" (Mém. Acad. Sci. Inst. France, t. xlv. no. 1), in which, amongst other forms, the following Cynthiidæ dealt with in the present paper are discussed, viz. *Forbesella tessellata*, *Styela rustica*, and *Polycarpa glomerata*. I must defer till some future opportunity a detailed examination of their results, and will now merely express my impression that what they describe as *rustica* and refer to the genus *Polycarpa* is not the northern and true *Styela rustica* (cf. *antea*, p. 448).

#### EXPLANATION OF THE PLATES.

##### PLATE XXXIII.

Fig. 1. Group of five individuals of *Ciona fascicularis*, Hnk.

2. A single solitary individual.
3. Base of clump of two individuals, showing the interlocking villosities.
4. Part of the branchial sac from the inside.
5. An individual removed from the test, natural size.
6. The alimentary canal, showing the posterior prolongation of the branchial sac.
7. The alimentary canal, showing œsophagus and stomach.
8. The tentacles, dorsal tubercle, and dorsal languets.

(All from Canon Norman's type specimens.)

##### PLATE XXXIV.

Fig. 1. Large specimen of *Ascidella aspersa*, from Lamlash Bay (? Hancock's *Ascidia Normani*).

2. Abnormal specimen of *Ascidella virginea* (= *Ascidia sordida*, A. & H.), from Firth of Forth.
3. Outline (reduced in size) of three individuals of *Ascidia affinis*, Hnk., sticking on small oyster-shell (from Canon Norman's types).
4. Individual of *Ascidia affinis*, with test removed, from left side to show enormous intestine.
5. Dorsal tubercle and tentacles of *Ascidia affinis*.
6. Dorsal tubercle from another individual.
7. Outline of specimen of *Ascidia crassa*, Hnk.
8. Dorsal tubercle of *Ascidia crassa*.
9. Part of branchial sac of same.
10. Individual of *Ascidia crassa* with test removed.

(Figs. 3 to 10 are from Canon Norman's type specimens.)

## PLATE XXXV.

(Figs. 1 to 6 are from Canon Norman's type specimens.)

- Fig. 1. *Ascidia producta*, Hnk., natural size, from right side.  
 2. The same species with the test removed, from left side, showing alimentary and reproductive organs, and renal vesicles scattered over the stomach.  
 3. The same, from the right side, showing the very faint muscles.  
 4. Tentacles and dorsal tubercle of same species.  
 5. Dorsal tubercle of another specimen of same species.  
 6. Part of branchial sac of same.  
 7. Tentacles and dorsal tubercle, &c., of a specimen of *Ascidia producta* from Tarbert, Loch Fyne (W. A. H.).  
 8. Mass of *Polycarpa glomerata*, from Port Erin.  
 9. Dorsal tubercle, &c., of *P. glomerata*.  
 10. Atrial tentacles of *P. glomerata*.  
 Figs. 11, 12, 13. Graphic branchial formulæ of 3 individuals of *P. glomerata*, showing the condition of the branchial folds, &c.

## PLATE XXXVI.

- Fig. 1. Viscera of *Styela rustica*.  
 Fig. 2. Viscera of *Styela monoceros*.  
 Figs. 3, 4, 5, 6, & 7 show different specimens of *Forbesella tessellata*, and give some idea of the range in variation of shape; natural size.  
 Fig. 8. Part of the branchial sac of *Forbesella tessellata*.  
 9. Tentacles, dorsal tubercle, and languets of *Forbesella tessellata*.  
 10. Interior of atrial siphon of same species, showing partial diaphragm.  
 11. Part of branchial sac of *Polycarpa quadrangularis*, Forbes.  
 12. Dorsal tubercle of *P. quadrangularis*.

Contributions to our Knowledge of the Arthropod Fauna of the West Indies.—Part II. Chilopoda. By R. I. Pocock, of the Natural History Museum. (Communicated by W. PERCY SLADEN, Sec. Linn. Soc.)

[Read 16th March, 1893.]

A GLANCE at the following list of the species of Chilopoda or Centipedes here enumerated as West Indian will show that the members of this group are neither numerous nor unknown. Only 5 species have been described as new, and 4 of these—namely, the two species of Geophilidæ, the *Cryptops*, and the *Newportia*—are of such small size, that they are not likely to come to hand again without special search. It is consequently probable that we shall have to wait many years before we discover whether or not they are peculiar to the Lesser Antilles.

But considering that the species of *Scolopendra*, *Rhysida*, *Oto-cryptops*, *Scolopocryptops*, one of the species of *Newportia*, not to mention three of the species of Geophilidæ, are found also on the mainland, it seems highly probable that the others, which are so far only known to be West Indian, will ultimately prove to have a wide range in the northern parts of the Neotropical Region.

Seeing that the species of *Scolopendra* occurring in North and Central America appear to be mostly well known, and that few new ones of unquestionable genuineness have been for some years recorded from the northern parts of South America, it is not likely—if one may venture to conjecture on such a point—that many new species of this genus will be brought to light in the West Indies. But with the genera that do not attain the dimensions of this last, such as *Cryptops* and the Geophilidæ, it must be far otherwise. It would indeed be the height of absurdity with our at present fragmentary knowledge on the point, to guess at the numbers of new species, and probably also new genera of Geophilidæ that could be discovered with a little diligent collecting.

A marked peculiarity in the West-Indian Chilopod fauna is the apparent absence of representatives of the family Lithobiidæ. That the genus *Lithobius*, however, does in reality not occur in these islands seems improbable; for it is exceedingly abundant in both North America and Mexico, and is not unknown in Brazil. It is much to be hoped that collectors in these islands will keep their eyes open for this Centipede.

The families that are at present known from the West Indies may be readily recognized as follows:—

- a. With only 15 pairs of legs; the legs extremely long and with multi-articulated tarsi; tracheæ opening upon the tergites; eyes compound . . . . SCUTIGERIDÆ.
- b. With from 21 to over 100 pairs of legs; legs short, and with mostly simple tarsi; tracheal stigmata opening beneath the terga; eyes absent, or formed of simple ocelli.
  - a<sup>1</sup>. With from 21–23 pairs of legs; many of the somites without stigmata . . . . . SCOLOPENDRIDÆ.
  - b<sup>1</sup>. With over 30 pairs of legs; a stigma found on each side of all the somites except the first and last; eyes always absent. . . . . GEOPHILIDÆ.

## Family SCUTIGERIDÆ.

1. SCUTIGERA GUILDINGII (*Newport*).

*Cermatia Guildingii*, *Newport*, *Tr. Linn. Soc.* xix. p. 356; *Cat. Myr. Brit. Mus.* pp. 10-11.

*Colour*: a wide ochre-yellow band in the middle of each tergite, forming with the others a continuous pale median dorsal longitudinal stripe which covers the stoma-saddles, the rest of the tergites a deep blackish green; the upper surface of the head pale on each side. Legs green proximally, obscurely banded, tibiæ subochraceous, tarsi entirely ochraceous; antennæ green, olivaceous distally.

*Head* depressed above in its posterior half.

*Tergites* strongly convex from side to side, only slightly uneven; the stoma-saddles wide, but not at all elevated, the posterior end of the stomata not reaching the posterior edge of the tergites; the tergites finely pubescent, and covered with small spicules. The last tergite with its hinder border very slightly emarginate.

Length 17 mm.

*Locality*. St. Vincent (*H. H. Smith*). One male example.

"Very rare, under stone, 500 ft.; a second example at 1000 ft. in rotten wood; a third example, measuring only 6.5 mm., at an altitude of 2000 ft."

2. \*SCUTIGERA SUPERBA, *Meinert*, *Vid. Medd. Nat. Foren.* 1886, p. 104.

*Colour* fulvous or flavous, the dorsal laminæ reddish brown, with a wide median chalky-white band, darker at the sides.

*Body* tolerably wide, narrowed behind and before; slightly convex.

*Head* deeply and triangularly depressed, with elevated smooth margins.

*Tergites* less highly marginate, rugulose, roughened, with sharp subserially arranged spines and very minute granules; the margin obscurely crenulate, manifestly fimbriate; the posterior margin produced into an obtuse angle, tolerably widely sinuate in the middle; the last tergite tolerably wide, posteriorly rounded and entire. *Stomata* evenly extended, longish.

"Length 30 mm.

*Locality*. West Indies."

This species, described from a single female, is unknown to me. In colour, which is perhaps one of the best specific characters for the genus, it appears to resemble closely the foregoing. On account, however, of its much greater size, I refrain from uniting the two.

### Family SCOLOPENDRIDÆ.

The West-Indian genera of this family may be recognized as follows:—

- a.* With 23 pairs of legs; eyes absent; tarso-metatarsi of most of the legs entire; prosternal plates of maxillipedes absent.
  - a*<sup>1</sup>. Anal legs without claw and with multi-articulated tarso-metatarsus; sulci of sterna cross-shaped, and of terga four in number. . . . . NEWPORTIA.
  - b*<sup>1</sup>. Anal legs normal; terga and sterna without sulci, or bisulcate.
    - a*<sup>2</sup>. Seventh somite without stigmata . . . . . OTOCRYPTOPS.
    - b*<sup>2</sup>. Seventh somite with stigmata . . . . . SCOLOPOCRYPTOPS.
- b.* With 21 pairs of legs.
  - a*<sup>3</sup>. Eyes absent; prosternal plates absent; tarso-metatarsi of most of the legs undivided; terga and sterna sulcate as in *Newportia*. . . . . CRYPTOPS.
  - b*<sup>3</sup>. Four eyes on each side of the head; prosternal plates present; tarso-metatarsi of all the legs divided.
    - a*<sup>4</sup>. The seventh segment with a pair of stigmata, the rest as in *Otostigma* . . RHYSIDA.
    - b*<sup>4</sup>. The seventh segment without stigmata.
      - a*<sup>5</sup>. Head-plate not overlapping the first tergite; stigmata small and sub-circular.
        - a*<sup>6</sup>. Head not sulcate; basal plate invisible; anal legs long and slender, and with small claws . . OTOSTIGMA.
        - b*<sup>6</sup>. Head sulcate; basal plate visible; anal legs shorter, very thick, with large claw . . . . . CUIPIPES.
      - b*<sup>5</sup>. Head overlapping the first tergite; stigmata large or elongate . . . . . SCOLOPENDRA.

3. *SCOLOPENDRA GIGANTEA*, *Linn.*

*Scolopendra gigantea*, *Linn. Syst. Nat.* ed. x. p. 638; *Newport, Porath, etc.*

*Scolopendra gigas*, *Leach, Tr. Linn. Soc.* xi. p. 383; *Newport, Kohlrausch, & Meinert.*

*Scolopendra insignis*, *Gervais, Ins. Apt.* iv. p. 279; *id. Voyage de Castelnau, Myriopoda*, p. 32, pl. v. fig. 1.

*Scolopendra prasinipes*, *Wood, P. Ac. Philad.* 1861, p. 11.

*Scolopendra epileptica*, *id. ibid.*

*Locality.* Jamaica (*Linné and Brit. Mus.*); St. Thomas (*Brit. Mus.*); Trinidad (*Meinert and Kohlrausch*). Occurs also in the northern parts of S. America.

4. *SCOLOPENDRA ANGULATA*, *Newport.*

*Scolopendra angulata*, *Newp. Ann. Mag. Nat. Hist.* xiii. p. 97 (1844); *id. Tr. Linn. Soc.* xix. p. 398 (1845); *id. Cat. Myr. Brit. Mus.* p. 47 (1856).

*Scolopendra prasina*, *C. Koch, Die Myr.* ii. p. 23, fig. 146 (1863); *Kohlrausch, Arch. Nat.* xlvii. p. 122 (1881); *Meinert, Proc. Am. Phil. Soc.* xxiii. p. 192; *Pocock, Ann. Mag. Nat. Hist.* (6) i. p. 338.

*Scolopendra nitida*, *Porath, Sv. Vet.-Ak. Handl.* iv. no. 7, p. 8.

The British Museum has this species from Trinidad and St. Vincent, where Mr. H. H. Smith obtained many specimens; Meinert has recorded it from Grenada. Occurs also on the mainland in Brazil, &c.

5. *SCOLOPENDRA ALTERNANS*, *Leach.*

*Scolopendra alternans*, *Leach, Tr. Linn. Soc.* xi. p. 383, *et auctt.*

*Scolopendra Grayi*, *complanata*, *incerta*, *multispinata*, *Newport, Tr. Linn. Soc.* xix. p. 402-405.

*Scolopendra sagræa*, *Gervais, Ins. Apt.* iv. p. 281.

*Scolopendra crudelis*, *Koch, Die Myr.* ii. p. 36, figs. 158, 159; *Porath, Sv. Vet.-Akad. Handl.* iv. no. 7, p. 7; *Meinert, Proc. Am. Phil. Soc.* 1886, p. 194.

*Scolopendra longipes*, *Wood, Proc. Ac. Philad.* (2) v. p. 26.

Known from the following W. Indian Islands:—Cuba, San Domingo, St. Thomas, St. Bartholomew, St. Croix, Guadeloupe. The British Museum has specimens from Hayti, St. Kitts, St. Eustace, Antigua, Montserrat, and Dominica. Also met with in S. America.

6. *SCOLOPENDRA SUBSPINIPES*, *Leach.*

*Scolopendra subspinipes*, *Leach, Tr. Linn. Soc.* xi. p. 383; *and all authors.*

The British Museum has this species from Jamaica (*Cockerell*),

St. Croix, Antigua, Montserrat, Dominica, St. Vincent, and Barbados. It has also been recorded from Porto Rico, St. Bartholomew, and St. Kitts by Porath, from Marie Galante and Guadeloupe by Gervais, and quite recently from Trinidad by Daday.

Common in tropical parts of both hemispheres.

7. *SCOLOPENDRA MORSITANS*, Linn.

*Scolopendra morsitans*, Kohlrausch, *Arch. Nat.* 1831 (47), p. 104 *et auctt.*

Recorded from St. Bartholomew and St. Kitts by Porath, from Cuba and ? St. Domingo by Gervais. The British Museum has specimens from Jamaica and Hayti.

Like *S. subspinipes* this species is abundant in all tropical countries.

*Scolopendra cubensis*, Sauss. (Mém. Soc. Phys. Genève, xv. pp. 387–388, fig. 47 (1860), and Humbert and Saussure, *Miss. Sci. Mex.*, Myriopoda, p. 132), is probably referable to *S. morsitans*.

The foregoing species of *Scolopendra* are well known to those who have systematically studied the genus. The following synopsis may aid in the rapid identification of them :—

- a. The first tergite marked anteriorly with a deep transverse groove; patella on 2nd segment of the anal leg spined; head longitudinally bisulcate.
  - a<sup>1</sup>. Sternites bisulcate; femora of all the legs apically spined ..... *gigantea*, Linn.
  - b<sup>1</sup>. Sternites not bisulcate; femora of only the last three pairs of legs (19th–21st) spined ..... *angulata*, Newp.
- b. The first tergite not marked anteriorly with a sulcus; patella of anal leg unarmed.
  - a<sup>2</sup>. Head-plate completely bisulcate; femora of 19th and 20th legs spined apically; femora of anal leg armed with upwards of 20–30 spines ..... *alternans*, Leach.
  - b<sup>2</sup>. Head not sulcate; femora of all the legs (except the anal) unarmed.
    - a<sup>3</sup>. Anal legs long and slender, armed beneath with 2 (3) spines ..... *subspinipes*, Leach.
    - b<sup>3</sup>. Anal legs shorter and stouter, armed beneath with 9 spines ..... *morsitans*, Linn.

8. *CUPIPES GUILDINGII* (*Newport*).

*Cormocephalus Guildingii*, *Newport*, *Tr. Linn. Soc.* xix. p. 425; *id. Cat. Myr. Brit. Mus.* p. 78 (1856).

*Cormocephalus impressus*, *Porath*, *Bih. Sv. Vet.-Akad. Handl.* iv. no. 7, p. 15 (1876).

*Otostigma cormocephalinum*, *Pocock*, *Ann. Mag. Nat. Hist.* (6) ii. p. 473, pl. xvi. fig. *a*; *id. op. cit.* vii. p. 53.

This species is widely distributed in the West Indies. *Porath* has recorded it from S. Domingo and St. Bartholomew. The British Museum has examples from St. Vincent (*H. H. Smith*), Dominica (*G. A. Ramage*), and Jamaica (*T. D. A. Cockerell*).

9. \**CUPIPES LINEATUS* (*Newport*).

*Cormocephalus lineatus*, *Newport*, *Tr. Linn. Soc.* xix. p. 425; *id. Cat. Myr. Brit. Mus.* p. 77.

"Colour ochraceous.

"*Antennæ* very thick at the base, with the segments short as in *Geophilus*.

"The *coxæ* of the maxillipedes narrowed anteriorly and marked with a triangular impression; the dental plates are distinct and elongated, with an elevated median crest, armed with six sub-obsolete teeth, the external one more distinct.

"The dorsal surface marked with longitudinal elevated lines.

"The anal pleuræ punctured; the sternite cordate, with the posterior margin rounded. The anal legs clavate, rounded; the femoral segment rounded, conical, very short, much shorter than the patella, with a single minute spine at its posterior angle, without spines on its lower surface; all the segments marked above posteriorly with a deep longitudinal sulcus."

Length  $1\frac{1}{2}$  inch (38 mm.).

*Locality.* St. Vincent (*Guilding*).

This species differs from *C. Guildingii* at least in the structure of its anal legs, for the femur of these appendages is described as much shorter than the patella and as having no spines on its lower surface.

10. \**CUPIPES UNGULATUS*, *Meinert*, *Proc. Am. Phil. Soc.* 1886, p. 187.

This species, which has been recorded by *Meinert* from Grande Anse and Port au Prince in Hayti, as well as from Pernambuco, is, to judge from the description of it, closely



related to *C. Guildingii*. But it undoubtedly differs in having all the tergites except the last immarginate. It may be recognized from *C. lineatus* by the spine-armature of the femur.

11. OTOSTIGMA SPICULIFERUM, sp. n.

*Colour* a deep green throughout.

*Body* slender.

*Head* finely punctulate. Coxal plates of the maxillipedes contiguous, armed with four distinct sharp teeth, the process on the femur well developed and subdentate. Antennæ long, composed of 17 long cylindrical segments, of which the basal two are naked and the rest pubescent.

*Tergites* from about the 6th bisulcate and from the 9th marginate; the middle of the dorsum marked between the sulci with two longitudinal impressions, the lateral portions at the posterior end of the body wrinkled; the tergites in the posterior half of the body distinctly spicular.

The *sternites* not conspicuously bisulcate, anteriorly rugose, posteriorly marked with four abbreviated longitudinal impressions, two median, in a line, and one on each side.

*Anal somite* small; *tergite* spicular above, with a shallow posterior impression; *pleuræ* moderately inflated, porous almost throughout, the inferior posterior angle a little produced but rounded and not spined; *sternite* narrow, narrower posteriorly; *legs* very long and slender, without spines, the segments sub-cylindrical; the tarsus unspined; claw spurred.

*Legs* with proximal tarsal segment spurred.

Length about 40 mm., of anal leg 13 mm., of antenna 10 mm.

*Locality*. St. Vincent (*H. H. Smith*).

"Pretty common in decaying leaves and under bark; sometimes obtained by beating vines and branches."

12. \*OTOSTIGMA OCCIDENTALE, *Meinert, Proc. Am. Phil. Soc.* 1886, pp. 185-186.

*Locality*. Grande Anse, Hayti (*Meinert*).

In its main characters this species is closely allied to the preceding. The differences, however, between the two may be easily tabulated as follows:—

- |  |                       |
|--|-----------------------|
| a. Antennæ composed of 21 shortish segments; the body  |                       |
| posteriorly hirsute .....                              | <i>occidentale</i> .  |
| b. Antennæ composed of 17 long segments; the body pos- |                       |
| teriorly spicular .....                                | <i>spiculiferum</i> . |

13. RHYSIDA LONGIPES, *Newport*.

*Branchiostoma longipes*, *Newport*, *Tr. Linn. Soc.* xix. p. 411.

The British Museum has a specimen of this species ticketed merely W. Indies. Meinert, however, recorded it from St. Croix and St. Kitts. It also occurs commonly in many parts of the Oriental Region. It may be readily recognized from the following species by the presence of spines upon the femora of the anal legs.

14. \*RHYSIDA CELERIS (*Humb. & Sauss.*).

*Branchiostoma celer*[e], *Humb. & Sauss. Rev. Mag. Zool.* (2) xxii. p. 202; *id. Miss. Sci. Mex., Myr.* p. 122, pl. vi. fig. 16; *Kohl. Arch. Nat.* xlvii. p. 69; *Meinert, Proc. Am. Phil. Soc.* 1886, p. 183.

This species is unknown to me. Meinert has recorded it from Kingston in Jamaica. It was described by its original authors from Georgia in N. America.

In this species the femora of the anal legs are said to be unarmed.

## 15. CRYPTOPS BIVITTATUS, sp. n.

*Colour*: head, antennæ, anal somite, and legs a uniform ochraceous; dorsal region testaceous, with two parallel longitudinal black bands.

*Head* hairy, not sulcate, a little longer than wide; antennæ parallel-sided, composed of 14 segments, adorned with longer and shorter hairs.

*Maxillary feet* also hairy; the anterior border of the coxæ straight and furnished with 6 bristles.

*First tergite* marked in front with a conspicuous transverse sulcus, which is angular in the middle. The rest of the tergites shortly hairy, normally sulcate, the longitudinal sulci beginning on the 3rd. *Sternites* furnished with the ordinary cross-shaped sulci.

*Anal somite*: tergite with raised margins; pleuræ setiferous in front, smooth behind, with a few setæ on the hinder border; angle rounded; sternite with evenly rounded posterior border. *Legs* thick; the femur thicker posteriorly, shorter than the patella, not spined, but thickly clothed below with setiform hairs, its upper surface posteriorly sulcate, but the posterior border unarmed; the patella flat and smooth on the inside, furnished with setiform spines elsewhere, sulcate above; the tibia a little shorter than the femur, about half as long as the patella and

thinner, flat internally, the inferior surface slightly excavated in front, the inner edge of the lower surface armed with 4 or 5 short spiniform teeth; the tarsus shorter than the tibia, excavated in front below, and armed internally with two small teeth; metatarsus slender, cylindrical, longer than the tarsus, carinate below; claw of normal size.

Length about 15.5 mm.

*Locality.* St. Vincent (*H. H. Smith*).

#### 16. OTOCRYPTOPS FERRUGINEUS (*Linn.*).

*Scolopendra ferruginea*, *Linn. Syst. Nat.* ed. 12, p. 1063; *De Geer, Mém. Hist. Ins.* vii p. 568, pl. 43. fig. 6.

*Scolopocryptops ferrugineus*, *Newport, Tr. Linn. Soc.* xix. p. 406 (1845); *id. Cat. Myr. Brit. Mus.* p. 56 (1856); *Karsch, Abh. Ver. Bremen*, xix. p. 66 (1884).

*Scolopocryptops rufa*, *Gervais, Ins. Apt.* iv. p. 297 (1847).

*Scolopocryptops mexicanus*, *Humb. & Sauss. Rev. Mag. Zool.* 1869, p. 158; *id. Myr. Miss. Sci. Mex.* p. 134, pl. vi. fig. 18 (1872); *Pocock, Ann. Mag. Nat. Hist.* (6) vi. p. 143 (1890).

*Scolopocryptops sexspinosa*, *Porath, Bih. Sv. Vet.-Akad. Handl.* 1876, no. 4, p. 26; *Kohlrausch, Arch. Nat.* 1881, p. 54 (in part); not syn. *sexspinosa* of Say.

*Scolopocryptops bisulca*, *Karsch, Abh. Ver. Bremen*, xix. p. 66 (1884).

*Scolopocryptops Miersii*, *Meinert, Pr. Am. Phil. Soc.* 1886, p. 181 (not syn. *Sc. Miersii* of Newport, *cf. supra*).

*Scolopocryptops Meinerti*, *Pocock, Ann. Mag. Nat. Hist.* (6) ii. p. 474 (1888).

This species has a wide distribution, being found on both sides of the Atlantic. Linnæus's type was from W. Africa, and Dr. Karsch has recorded it from Accra. Moreover the British Museum has a specimen ticketed W. Africa, and since this is not distinguishable specifically from *Sc. mexicanus* of Humb. & Sauss., I have been compelled to adopt the older name for the species.

But although occurring in Africa, the species seems to have its headquarters in the Neotropical Region; for it is abundantly distributed throughout Central America, the West Indies, and the northern parts of South America.

In the West Indies it is known from the following localities:—Hayti, Jamaica, and Martinique (*Meinert*); the British Museum has examples from Cuba, Jamaica (*T. D. A. Cockerell*), St. Vincent (*H. H. Smith*), and Dominica (*G. A. Ramage*).

No description of this species need be here added, for it has been well figured by de Saussure and described in detail by myself under the name of *Scolopocryptops Meinerti*.

17. OTOCRYPTOPS MELANOSTOMA (*Newport*).

*Scolopocryptops melanostoma*, *Newport*, *Tr. Linn. Soc.* xix. p. 406; *id. Cat. Myr. Brit. Mus.* p. 56.

*Scolopocryptops melanos[t]oma*, *Gervais*, *Ins. Apt.* iv. p. 298.

*Scolopocryptops longiceps*, *Pocock*, *Ann. Mag. Nat. Hist.* (6) viii. p. 160 (1891).

*Scolopocryptops megacephalus*, *Kohlrausch*, *Arch. Nat.* 1881, p. 57.

*Body* robust, attenuated posteriorly.

*Colour* fusco-castaneous or ochraceous above; head and maxillipedes castaneous.

*Head* longer than wide, nearly parallel-sided, its posterior angles rounded; coarsely punctured, and with simple margins. *Antennæ* only moderately long, composed of 17 segments, of which the basal two are naked.

*Maxillipedes* coarsely punctured; coxæ very wide, with anterior border widely and shallowly excavated, without teeth, but thickened; the femoral tooth large and conical.

*Tergites* smooth, polished, punctured, from the 3rd to the 21st bisulcate, and from the 7th to the 21st with raised margins.

*Sternites* punctured, not sulcate.

*Anal somite* small; *tergite* neither sulcate nor marginate; *pleuræ* not spined above, covered with larger and smaller pores, the process and posterior border only being smooth, the process very long; *sternite* posteriorly narrowed, its hinder border emarginate. *Legs* long, slightly pubescent distally; the spines of the femur large, the inferior one being especially long and strong; tarsus unarmed, claw not spurred.

*Legs* for the most part with tibial and tarsal spurs, the 22nd pair not spurred; all the claws without conspicuous basal spurs.

Length up to 60 mm.

*Locality.* St. Vincent (*H. H. Smith*).

The example measuring 60 mm. is the type of *Scolopocryptops longiceps* from Brazil; the example from St. Vincent is but 45 mm.

When I published the description of *Sc. longiceps* I had not seen an example of this genus from St. Vincent. But since Mr. H. H. Smith obtained a specimen from this island, whence Newport's type of *Sc. melanostoma* was recorded, I have decided

to recharacterize this specimen as *Otocryptops melanostoma*, although the original description of this species might well be applied to *O. ferrugineus*.

The two species may be readily distinguished thus :—

- a. Border of maxillary coxæ straight and dentate ;  
claws of legs spurred &c. .... *ferrugineus* (Linn.).
- b. Border of maxillary coxæ emarginate and not  
dentate ; claws without distinct spurs &c. ... *melanostoma* (Newp.).

#### 18. SCOLOPOCRYPTOPS MIERSII, *Newport*.

*Scolopocryptops Miersii*, *Newport, Tr. Linn. Soc.* xix. p. 405 (1845) ;  
*id. Cat. Myr. Brit. Mus.* p. 56 (1856). *Not Sc. Miersii, Kohtrausch, Arch. Nat.* 1881, p. 55 ; *Meinert, Proc. Am. Phil. Soc.* 1886, p. 181.

*Colour* piceo-castaneous, often with a distinctly olivaceous tint ; antennæ olivaceous ; legs ochraceo-olivaceous, smooth and shining. Body robust, attenuated posteriorly.

*Head* orbicular, as wide as long, with convex posterior border, somewhat coarsely punctured, without trace of sulci, and with margin simple.

*Antennæ* long, attenuated, and slender, composed of 17 segments, of which the basal three are naked, and the rest densely pubescent.

*Coxæ* of maxillipedes smooth, shining, punctured like the head, lightly wrinkled in front, the dental border straight, black, with a small tubercular tooth at each end of it ; the tooth on the femoral segment small, tubercular, and simple.

*First tergite* with a strong crescentic anterior transverse sulcus, punctured ; the rest of the tergites punctured, from the 8th or 10th bisulcate, and from the 8th with raised margins.

*Sternites* without sulci.

*Anal somite* small ; *tergite* punctulate, not sulcate, parallel-sided, its posterior border mesially produced, its lateral borders not elevated ; the *pleuræ* covered thickly and closely throughout with minute pores, the area surrounding the surface of articulation of the femur smooth and spiniform above, the pleural process robust and somewhat short, tipped with a single spine ; *sternite* posteriorly narrowed, twice as wide in front as behind, the angles rounded, the posterior border lightly emarginate. *Legs* long and slender, smooth, the segments subcylindrical, compressed, the spines on the femur evanescent, very small ; claw spurred at the base. Rest of the legs with spurred claws, a

tarso-metatarsal spine and an anterior and inferior spine at the distal end of the tibia.

*Measurements in millims. of largest example.*—Length 109, width of head 8·5, of 1st tergite 10·8, of 12th 11, of 23rd 5; length of antenna 31·5, of anal leg 33.

*Locality.* Santa Lucia, Fond de Jacques (*G. A. Ramage*).

Five examples were obtained at the above locality. The example of which the measurements are given above is the largest of the five, and is, moreover, much larger than any previously recorded example of this genus, or of *Otocryptops*. The second measures 107 mm., the third 91, the fourth 69, and the fifth 60. The third example is about the size of Newport's type, which was recorded from Brazil. In addition to the specimens here recorded the British Museum has one from Brazil that was ticketed *Miersii* by Newport himself, and a second from Rio. This is the first record of the genus from the West Indies. Kohlrausch in 1881, in his 'Monograph of the Scolopendridæ,' referred this species to *Otocryptops sexspinosus* (Say), but quite wrongly, and Meinert in 1886 fell into the error of supposing it to be the same as *Ot. mexicanus* of de Saussure.

18 a. \*SCOLOPOCRYPTOPS ANTILLARUM (*Marsh*), *Trans. Ent. Soc.* 1878, p. xxxvii.

This species was recorded from Martinique, but since its author knew but little of the Scolopendridæ, it need scarcely be added that no opinion can be formed as to the validity of his species.

19. NEWPORTIA LONGITARSIS (*Newport*).

*Scolopocryptops longitarsis*, *Newp. Tr. Linn. Soc.* xix. p. 407, pl. xl. fig. 10 (1845).

*Newportia longitarsis*, *Gervais, Ins. Apt.* iv. p. 298.

*Newportia longitarsis*, *Newport, Cat. Myr. Brit. Mus.* p. 57 (1856).

Not *Newportia longitarsis*, *Bollman, P. U.S. Nat. Mus.* 1888, pp. 337, 338.

*Colour* ochraceous, head and maxillipes castaneous.

*Head* elongate, rounded posteriorly, without distinct sulci.

*Antennæ* shortish, robust, densely pubescent, lineate at the base. Maxillipedes with the anterior border of the coxæ not produced, nearly straight from side to side, with a very faint notch in the middle line. First tergite furnished in its anterior half with a transverse sulcus arched so as to form the segment of a circle. The rest of the tergites quadrisulcate as in *Cryptops*; the central area in addition marked each side with

two depressions which cause the middle line to appear lightly carinate.

The *sternites* marked with a median sulcus, and with a second sulcus on each side close to the lateral margin; the normal median transverse sulcus indistinct.

*Anal somite*: tergite with elevated margins, lightly depressed posteriorly; *pleuræ* porous, produced into a long, pointed, smooth process, which extends just beyond the level of the apex of the first spine of the femur; *sternite* elongate, narrowed posteriorly, lightly emarginate behind. *Legs* long and very hairy; the femur armed beneath with a series of four strong spines, also studded with spiniform hairs; the *patella* a little shorter and slenderer than the femur, armed internally in its proximal half with two smaller spines; the tibia as long as the patella, but slenderer, unarmed, these three segments notched above at their distal ends but not spined; the tarso-metatarsus almost as long as the rest of the leg, composed of eleven distinct longish cylindrical segments, these segments excepting the first one are subequal in length but the distal ones are narrower; the first segment is about half the length of the tibia, and as long as the two that succeed it.

*Legs* long, slender, and hairy, the 22nd pair extending almost to the posterior end of the patella of the anal leg.

Length 15 mm.; of anal leg 5.8 mm.

*Locality*. St. Vincent (*H. H. Smith*).

The example of this species that has been described above agrees closely with Newport's diagnosis of *N. longitarsis*. The type, however, was a very much larger specimen, for Newport gives  $1\frac{3}{4}$  inches (44 mm.) as its total length.

Of the species of this genus established since Newport characterized *N. longitarsis*, the one that comes nearest to it is *N. monticola*, Pocock, from Chimborazo. The two are alike in the form of the sulcus on the first tergite, and of the anterior border of the coxæ of the maxillipedes, so also in the spine armature of the anal legs; but *N. monticola* may be readily recognized by the much greater length of the proximal segment of the tarso-metatarsus, which is almost as long as the tibia, and in the shortness of the tarsus and the fewness of its segments. Both the species differ from *N. dentata* in the shape of the sulcus of the first tergite, which is angular in the last named. *N. dentata* also has the maxillary coxæ produced forwards anteriorly.

20. *NEWPORTIA PUSILLA*, sp. n.

*Colour*: head and first tergite and anal tergite ochraceous; body dark green mottled with ochraceous; legs pale green; antennæ yellow.

*Head* hairy, punctured, not sulcate. Antennæ composed of seventeen short segments, shortly and thickly hairy. Maxillipedes hairy, anterior border of the coxæ straight with a median notch. First tergite with a strong arched groove running from the anterior angle on one side to that of the other, and reaching nearly to the middle of the plate; the longitudinal sulci invisible.

*Terga* and *sterna* normally sulcate.

*Anal somite* also normal, the pleuræ somewhat scantily porous. *Legs* hairy, with *femur* and *patella* about equal in length, the tibia a little shorter; the *tarso-metatarsus* composed of ten distinctly defined segments, of which the first is rather more than half the length of the tibia, the second being a little shorter and thinner than the first, as the third is with regard to the second; the seven distal segments shorter, the seventh ovate.

Length 10.5 mm.

*Locality*. St. Vincent (*H. H. Smith*).

This species, with its distinctly segmented anal tarsi and the large spines on the lower surface of the anal femur, falls into the same category with the three mentioned above. It may be recognized from them, however, by the presence of only three spines on the femur, and none on the patella of the anal leg.

21. *NEWPORTIA ERNSTII*, *Pocock, Ann. Mag. Nat. Hist.* (6) viii. pp. 161-163.

*Locality*. St. Vincent (*H. H. Smith*).

This species was originally described from a specimen received from Caraccas from Dr. Ernst; the Museum also has an example from Brazil. Consequently there is very little doubt that the species has been introduced into St. Vincent from the mainland of S. America.

It cannot be confounded with either of the preceding on account of the indistinctness and number of the segments of its anal tarsi, the spine armature of the anal legs, sulcation of head-plate and first tergite, &c.

22. \* *NEWPORTIA*, sp. n.

*Newportia longitarsis*, *Bollman, Proc. U.S. Nat. Mus.* 1888, pp. 337, 338.



*Locality*, Cuba.

I will not venture to propose a name for the Cuban species identified by Bollman as *N. longitarsis*. That it is not *longitarsis* I am persuaded, but whether or not it is one of the other species of the genus, the description of it is not sufficiently detailed to show. The border of the maxillary coxæ is not produced; the femora of the anal legs are armed with about twenty-two larger and smaller hooked spines arranged in four or five series, and the tibia with two long spines beneath.

Length 28 mm.

## Family GEOPHILIDÆ.

*Synopsis of the Genera.*

- a. The basal plate very small, narrower than the head and first tergite, and wedged in between the head in front, the first tergite behind, and the pleuræ of the maxillipedes at the sides; the coxæ of the maxillipedes largely uncovered above by the pleuræ ..... MECISTOCEPHALUS, Newp.
- b. The basal plate much larger and free, at least as wide as the head.
  - a<sup>1</sup>. The pleural sclerites which bear the tracheæ in contact with the tergites; the porous areas situated along the posterior extremities of the sterna.
  - a<sup>2</sup>. Basal plate narrowed anteriorly; antennæ long, slender, the segments longer than wide ..... GEOPHILUS, Leach.
  - b<sup>2</sup>. Basal plate as wide in front as behind; antennæ short, stout, the segments wider than long ..... TÆNIOLINUM, nov.
  - b<sup>1</sup>. The tracheal sclerites of the pleuræ separated from the tergites; porous areas not situated along the posterior borders of the sterna.
    - a<sup>3</sup>. With only one row of sclerites between the terga and the tracheal sclerites; the pleuræ of the anal segment very small; anal leg composed of 6 segments plus the pleura ..... ORPHNÆUS, Mein.

- b*<sup>3</sup>. With more than one row of sclerites between the terga and the tracheal sclerites ; anal leg composed of only 5 segments plus the pleura ..... NOTIPHILIDES, Latr.

23. *MECISTOCEPHALUS GUILDINGII*, *Newport*.

*Mecistocephalus Guildingii*, *Newport*, *Tr. Linn. Soc.* xix. p. 429, pl. xxxiii. fig. 18 ; *Meinert*, *Nat. Tidskr.* (3) vii. p. 96.

This species was originally described from St. Vincent, but Mr. Smith did not rediscover it in this island. Mr. Cockerell has sent it to the British Museum from Jamaica ; Mr. Bollman has recorded it from Cuba, and Meinert from St. Croix.

By some authors, *e.g.* Meinert and Bollman, this species is regarded as synonymous with the Oriental form *M. punctifrons*, which it resembles in having forty-nine pairs of legs. All the Neotropical examples, however, that I have seen are smaller and paler coloured than *M. punctifrons*, and seem to have the head considerably narrower.

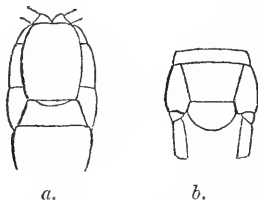
24. *GEOPHILUS TENUITARSIS*, *Pocock*.

*Geophilus tenuitarsis*, *Pocock*, *Ann. Mag. Nat. Hist.* (6) ii. pp. 475, 476, pl. xvi. fig. c.

*Locality.* Dominica (*G. A. Ramage*).

25. *GEOPHILUS MUSTIQUENSIS*, *sp. n.*

*Colour* ochraceous, with the head pale castaneous ; the dorsal surface in one specimen clouded with fuscous.



*Geophilus mustiquensis*, *sp. n.*

*a.* Head from above. *b.* Anal segment from below.

*Head* only a little longer than wide, sparsely punctured, and lightly bi-impressed. *Antennæ* of moderate length and thickness,

hirsute ; the segments slightly narrowed at the base, the apical a little longer than the penultimate.

The *prebasal plate* just visible ; the *basal plate* about twice as wide as long, a little narrower than the head in front, and narrower than the first tergite behind.

*Coxal plate* of the maxillipedes considerably overlapped posteriorly on each side by the pleuræ, about as wide as long, sparsely punctured, the anterior border emarginate, considerably overlapping the head-plate at the sides ; the jaws moderately long, the claw a little overlapping the head-plate in front, but the joint of it falling considerably short of the basal joint of the antenna.

*Tergites* smooth, somewhat strongly bisulcate.

*Sternites* smooth, but mesially impressed.

*Anal somite*: tergite wide, almost completely covering the pleuræ ; *pleuræ* smooth and not porous ; *sternite* wide, wider than long. Legs slender, hairy, not much longer than the preceding pair, without a claw, or at most with a very minute one ; in ♂ distinctly thicker.

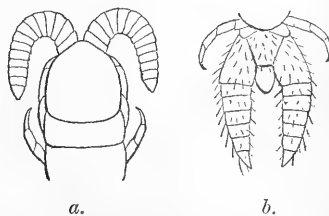
Number of pairs of legs, ♀ 49, ♂ 45.

Length up to about 31 mm.

*Locality*. Mustique Island (*H. H. Smith*).

"Under rubbish in damp places."

This species may be readily recognized from *G. tenuitarsis* by the much smaller number of its legs, *G. tenuitarsis* having as many as eighty-five pairs.



*Tæniolinum setosum*, gen. & sp. n.

a. Head from above. b. Anal segment from below.

#### TÆNIOLINUM, gen. nov.

*Head* orbicular, nearly covering the maxillipedes ; *antennæ* very short and stout. *Prebasal plate* invisible ; *basal plate* as

wide as the head and the first tergite, about twice as wide as long. *Maxillipedes* weak. *Tracheal* sclerites in contact with the tergites. *Porous area* apparently situated transversely upon the posterior portion of the sternites.

In the form of the head, basal plate, and antennæ this genus seems to resemble *Orphnæus*, but it differs very markedly from it in the structure of the anal somite, with its large pleuræ, thick legs, &c.; moreover the tracheal sclerites are in contact with the tergites.

In the position of its sternal pores it resembles *Geophilus*, but it may be readily recognized by its short thick antennæ, wide basal plate, &c.

## 26. TENIOLINUM SETOSUM, sp. n.

*Head* thickly setose; *antennæ* with their segments wider than long, the apical conical. The coxæ of the *maxillipedes* largely overlapped on each side by the pleural sclerites; without chitinous lines, the anterior border lightly emarginate; femora short, unarmed, the joint of the claw falling far short of the anterior border of the head. *Tergites* thickly hairy, not bisulcate. *Sternites* also hairy.

*Anal somite* setose, wide, the tergite as wide as that of the preceding; leg-bearing somite like a half-moon, with the convexity posterior; *pleuræ* large, projecting laterally far beyond the margin of the tergite, without pores above, but possibly porous close to and beneath the sternite, densely hairy; *sternite* of moderate size, triangular, with truncated posterior end. *Legs* enormously stout at the base, the first segment as wide as the pleura, gradually tapering towards the distal segment, compressed, hairy, not tipped with a claw, or at least with only a minute one. The rest of the legs thickly hairy.

Number of pairs of legs 49.

Length up to about 13 mm.

Two examples (♂) from St. Vincent (*H. H. Smith*), one at an altitude of 1500 ft., the other in moss in the forest at an elevation of 3000 ft.

## 27. ORPHNÆUS BREVILABIATUS (*Newport*).

*Geophilus brevilabius*, *Newport*, *Tr. Linn. Soc.* xix. p. 436, no. 9 (1845).

*Geophilus lineatus*, *id. ibid.* no. 10.

*Geophilus bilineatus*, *Peters, Reise Mossam., Ins.* p. 531, pl. xxiii. fig. 4.

*Orphnæus lividus*, *Meinert, Nat. Tidskr.* (3) vii. p. 19.

*Orphnæus brasiliensis*, *id. ibid.* p. 20.

*Orya xanti*, *Tömösvary, Term. füzetek*, ix. p. 64 (1885).

This species is found in all tropical countries, and is perhaps the commonest in collections of all exotic Geophilidæ.

Mr. Bollman has recorded it from Cuba, and Mr. Cockerell has sent it to the British Museum from Jamaica.

## 28. NOTIPHILIDES MAXIMILIANI (*Humb. & Sauss.*).

*Notiphilus Maximiliani*, *Humb. & Sauss. Rev. et Mag. Zool.* (2) xxii. p. 205; *id. Etudes sur les Myr.* p. 141, pl. vi. fig. 22.

*Notiphilides Maximiliani*, *Latzel, Die Myr. Oest.-Ung. Monarchie*, i. p. 20; *Meinert, Proc. Am. Phil. Soc.* 1886, p. 233.

An example of this species, which has hitherto been recorded only from Central America, has been sent to the British Museum from Trinidad.

Contributions to our Knowledge of the Arthropod Fauna of the West Indies.—Part III. Diplopoda and Malacopoda, with a Supplement on the Arachnida of the Class Pedipalpi. By R. I. Pocock, of the Natural History Museum. (Communicated by W. PERCY SLADEN, Sec. Linn. Soc.)

[Read 16th March, 1893.]

(PLATES XXXVII.—XL.)

## I. DIPLOPODA.

UNDOUBTEDLY the most interesting and important feature in the Antillean Diplopod fauna brought to light by the collectors employed by the Committee for the Exploration of the Lesser Antilles (*vide antea*, p. 374) is the discovery, or rather re-discovery, of *Glomeridesmus*. This genus has been a puzzle to systematists for upwards of half a century, no one having been able to assign to it a position in any of the recognized families. There is no doubt, however, that it should constitute a distinct family of its own, occupying a position between the groups to which I have given the names *Oniscomorpha* and *Helminthomorpha*. Its affinities, nevertheless, appear to be rather with the former than with the latter, on account of the absence of

copulatory feet on the 7th segment, and the incompleteness of the anal segment.

The collector, Mr. H. H. Smith, may also be congratulated upon the discovery of *Polyxenus*, which is new to the Neotropical Fauna. The genus *Siphonotus*, too, which has been long lost sight of, is worthy of special mention.

These three forms are all of very small size, and they may be taken as probably a fair criterion of what may yet be accomplished in this group if collectors will pay attention to the minute as well as the more striking species.

In the present state of our knowledge of the Neotropical Diplopod fauna, it is impossible to enter into a detailed comparison between that of the Antilles and of any other area of the Region. As a rule the species of this group are very restricted in range. This is well shown in the present instance by the fact that in only one or two cases is a species found beyond the limits of a single island. Thus in the case of Dominica, St. Vincent, Santa Lucia, and Grenada, with the Diplopod fauna of which we may now perhaps consider ourselves fairly well acquainted, it is noticeable that each seems to have its peculiar species of *Rhinocricus*. In Dominica, *R. leucostigma* is very abundant; in St. Vincent *R. macropus* and *R. vincentii* alone occur; while in Santa Lucia many species were found which did not extend to the neighbouring islands. Most of these species, however, are obviously very closely related to each other, and they belong to a group which is apparently rather characteristic of the northern parts of S. America.

### Class PSELAPHOGNATHA.

#### Family POLYXENIDÆ.

POLYXENUS LONGISETIS, sp. n. (Pl. XXXVII. fig. 1.)

*Colour* (in alcohol) pale; the setæ greenish.

The body slightly attenuated posteriorly, with 10 dorsal plates visible between the head and the posterior tuft of setæ, the last plate narrower than the preceding one and sometimes appearing to be concealed inside it.

The antennæ very long, projecting on each side far beyond the sides of the body; the setæ on the lateral processes very long; the posterior tuft of setæ much narrower than in *P. lagurus*.

*Locality.* Mustique Island, under decaying leaves ; St. Vincent (Ballein, north end of island), in bed of stream beneath sod, on rock (*H. H. Smith*).

### Class CHILOGNATHA.

#### Order LIMACOMORPHA, *Pocock*.

##### Family GLOMERIDESMIDÆ, *Latzel*.

*Body* consisting of 19–20 segments ; the segments subequal in size and subsimilar in form, none of them being abruptly larger than the rest, although they decrease in size from the middle of the body to its anterior and posterior ends.

*Head* convex and elongate from above downwards ; the antennæ moderately long, consisting of 7 subequal segments.

*Eyes* apparently represented by a large circular depression above and behind the base of the antennæ\* ; at the bottom of this depression, along the posterior portion of it, is a curved series of (4) colourless tubercles, which perhaps are ocelli.

The *mandibles* well developed, apparently without the basal segment or *cardo* ; the *gnathochilarium* with a large T-shaped sclerite representing the mentum and promentum ; the lingual lobes short and contiguous ; the stipites widely separated throughout their extent as in *Glomeris*, each tipped with two malæ ; the hypostoma large and crescentic.

*Each segment*, except the last, consisting of a vaulted tergal piece and a free pleura on each side. The first four furnished with a single pair of legs each ; the rest with two pairs of legs, except the last, which is apodous and is represented merely by a tergal sclerite.

No tracheal plates (pedal laminæ) lying between the pleuræ and the bases of the legs.

The *legs*, including the enlarged basal segment, consist of 6 segments, of which the second, fourth, and fifth are short, the third and sixth long.

In the male the legs of the seventh segment are not modified for copulatory purposes, but the last pair (*i. e.* the posterior pair of the penultimate segment) are shortened, thickened, and capable

\* This organ seems to be the homologue of the horseshoe-shaped 'sensory' organ of *Glomeris*.

of retraction inside the segment that bears them; each consists apparently of four segments, the distal of which is tipped by a long seta, which looks as if it were the distal segment of a normal leg immensely reduced in thickness.

There are two large penes, capable of protrusion, between the second and third pairs of legs.

Repugnatorial pores not developed.

There are no chitinous anal valves or anal sternite, the integument round the anus being membranous.

I recognize two genera belonging to this family. They may be characterized as follows:—

- a. The bases of the antennæ closer together;  
the antennal socket closed behind ..... ZEPHRONIDESMUS.  
Type, *sumatranus*, Poc.
- b. The bases of the antennæ separated by a  
wider frontal space; the antennal socket  
open behind ..... GLOMERIDESMUS, Gerv.  
Type, *porcellus*, Gerv.

Unfortunately I can only judge of the characters of *Glomeridesmus* from the St. Vincent species known to me. It may, however, be assumed as probable, on geographical grounds, that this species will prove to be congeneric with the Colombian species *porcellus*.

#### Genus GLOMERIDESMUS, *Gervais & Goudot*.

*Glomeridesmus*, *Gervais & Goudot*, *Ann. Soc. Ent. Fr.* (2) ii. p. xxvii (1844); *ibid. Ann. Sci. Nat.* (3) ii. p. 62, pl. v. figs. 4-6; *Gervais, Ins. Apt.* iv. p. 87, pl. 44. fig. 6.

GLOMERIDESMUS MARMOREUS, sp. n. (Pl. XXXVII. figs. 2-2*m.*)

*Colour* blackish grey, symmetrically spotted with yellow; head black, with a transverse yellow band across the summit, and a yellow labrum; lower surface pale, antennæ fuscous.

*Head* smooth and shining. Antennæ rather short, the 3rd to the 6th segments constricted proximally.

The first tergite evenly narrowed laterally, about as wide as the head. The rest of the tergites evenly arched, lightly transversely ridged, ridges curving abruptly backwards laterally; the posterior border straight; the posterior angle rectangular, but at the posterior end of the body produced into a backwardly-directed spike, which is particularly noticeable on the last



segment but one. There is an indistinct row of short setæ running transversely along the posterior third of the tergites.

The *pleuræ* are finely and transversely ridged in front like the terga; their posterior borders are finely serrate and distinctly angled.

The penes are long, nearly white, tapering and furnished with close-set transverse series of fine short setæ.

Length 7 mm., width 1·7 mm.

*Locality.* St. Vincent (*H. H. Smith*).

Mr. Smith obtained a considerable number of specimens which bear the following labels:—Leeward side of island, 1000 ft.; Richmond Valley, 1800 ft.; Mountain Forest, 2800 ft. and 3000 ft. In the latter two cases it is stated that the animals were found under rotting leaves.

## Order HELMINTHOMORPHA.

### Suborder CALLIPODOIDEA.

#### Fam. nov. STEMMIULIDÆ.

(Pl. XXXVII. figs. 3–3 c.)

On a previous occasion I referred the genus *Stemmiulus* to the Callopodidæ\* in preference to leaving it in the Iulidæ, where it was placed by Karsch. But further reflection and study have convinced me that perhaps the affinities of this peculiar genus are best expressed by the establishment of a special family for its reception.

The family differs from the Callipodidæ in having the eyes composed of only one or two ocelli on each side, in the structure of the gnathochilarium (*cf.* figure), in the partial or complete freedom of the pleuræ, in having the terga almost undivided by a transverse groove, &c.

\* I here follow Mr. Bollman (Bull. U. S. Nat. Mus. no. 46, p. 189, 1893) in regarding the genus *Callipus* of Risso as synonymous with *Lysiopetalum* of Brandt. The adoption of this view necessitates the change of the family name *Lysiopetalidæ* to *Callipodidæ*, and since Bollman has created the superfamily Callipodoidea for the family, I propose to follow substantially the same course; but I prefer to call the group a suborder, equal in value to the Iuloidea, Pocock, or Chordeumoidea (Cook & Collins), and consequently, for the sake of uniformity, I call it Callipodoidea. The suborder will contain the Stemmiulidæ as well as the Callipodidæ.

\*STEMMIULUS COMPRESSUS, *Karsch, Zeits. Naturwiss.* (3) vi. pp. 11, 12.

*Locality.* Porto Rico.

Two Neotropical species of the genus *Stemmiulus* have been described: the first, named *bioculatus* by Gervais, was from Colombia; the second is the species mentioned above from Porto Rico. The latter I have not seen; but it appears to differ from the Colombian form in possessing two eyes on each side of the head. Species to which an \* is prefixed have not been seen by the writer.

## Suborder COLOBOGNATHA.

### Family SIPHONOPHORIDÆ.

#### Genus SIPHONOPHORA.

\*SIPHONOPHORA PORTORICENSIS, *Brandt*.

*Siphonophora portoricensis*, *Brandt, Bull. Ac. St. Pétersbourg*, i. (1837) p. 179; *Gervais, Apt.* iv. p. 209 (1847); *C. Koch, Die Myriapoden*, i. p. 90, fig. 78 (1863); *Peters, Mon. Ak. Wiss. Berlin*, p. 549 (1864).

Body linear, hairy. The antennæ projecting as far as the apex of the rostrum. The first tergite mesially emarginate in front, and as long as the two following segments.

Number of segments 71-72.

Length 20 mm., width 1 mm.

*Locality.* Porto Rico.

\*SIPHONOPHORA CUBANA, *Karsch, Mitth. Münch. ent. Ver.* 1880, p. 144.

Somewhat depressed, brown; head, rostrum, antennæ, and legs flavous. Rostrum longer than the head, the antennæ scarcely longer than the rostrum, clavate; first segment not twice as wide as the head, deeply emarginate in front, not longer along the dorsal middle line than the second segment; the segments dorsally tolerably thickly covered with short setiform hairs.

Length 7-8 mm.

*Locality.* Cuba.

Appears to differ from *S. portoricensis* of Brandt in its much smaller size, wider head, and much shorter rostrum.

This species was looked upon by Bollman (*Proc. U. S. Nat. Mus.* 1888, p. 335), who also had it from Cuba, as synonymous with *S. portoricensis* of Brandt. I prefer, however, at present

at least, to look upon the two as distinct. I have seen no specimens which justify Bollman's views on the variability of the length of the rostrum.

*SIPHONOPHORA TENUICORNIS*, sp. n. (Pl. XXXVII. fig. 4.)

*Colour* entirely ochraceous.

The *rostrum* long and slender, about twice as long as the head, lightly curved. *Antennæ* long and slender, only gradually and slightly incrassate.

Number of segments about 106.

Length about 20 mm.

*Locality*. St. Vincent (*H. H. Smith*.)

"Forest, Morne a Garou, 1500 ft. In rotten wood."

This species differs from *S. luteola*, Gerv., and *S. mexicana*, Sauss., the only American species of the genus that are known to me, in the length and slenderness of its antennæ.

### Family POLYZONIDÆ.

#### Genus SIPHONOTUS.

*SIPHONOTUS PURPUREUS*, sp. n. (Pl. XXXVII. fig. 5.)

*Colour* (in alcohol) a purplish red; legs pale.

*Body* elongate and slender, not entirely concealing the legs.

*Head* triangular, gradually narrowed to a pointed rostrum, apparently furnished on each side with two large, black, prominent eyes, the upper of which are covered by, but visible through, the first tergite. *Antennæ* considerably longer than the head and very thick, being almost of a uniform thickness throughout. The segments smooth and polished; the anal segment much narrower than the one that precedes it. *Legs* tolerably long.

Number of segments 37-44.

Length up to about 7 mm.

*Locality*. St. Vincent (*H. H. Smith*.)

"Mountain forest, 2500 ft. Under bark. Colour light purple."

This species appears to me to differ generically from the Palearctic *Polyzonium germanicum*, since it is much more slender and has fewer eyes. There can be little doubt that it is congeneric with the species to which Brandt gave the generic name *Siphonotus*.

## Suborder IULOIDÆ.

## Family IULIDÆ (s. s.).

[= Iulinæ, *Bollman* + Paraiulinæ, *Bollman* + ? Nemasominæ, *Bollman*; *Bollman*, *Bull. U. S. Nat. Mus.* no. 46, p. 156 (1893).]

## Genus IULUS.

\*IULUS CURIOSUS, *Karsch, Zeits. Naturwiss.* (3) vi. p. 15.

♀. Moderately slender. Grey; feet testaceous and antennæ black. Head smooth; antennæ surpassing the second segment; collum laterally tolerably widely rounded, nearly reaching the inferior margin of the second ring. The sulci on the segments deep, the anterior area smooth, the posterior tolerably densely longitudinally sulcate. Pores large, scarcely above the middle of the side, immediately in front of the sulcus. Anal tergite posteriorly angled; valves hairy, feebly convex.

Number of segments 47.

Length 36 mm.

*Locality.* Porto Rico.

\*IULUS CÆSAR, *Karsch, Zeits. Naturwiss.* (3) vi. p. 18.

Colour fusco-brunneous, nearly concolorous.

Head smooth; clypeus with two foveæ and a few striæ.

Collum sensibly angularly rounded, not reaching the inferior border of the second ring, marked with abbreviated sulci, forming three marginal folds. The segments completely sulcate, the anterior portion sculptured with fine striolæ, the posterior portion tolerably densely striate, the striæ above not attaining the posterior portion. The pores high above the middle of the side, a little behind the sulcus. Anal tergite forming a very acute caudal process, which surpasses the valves a little; valves and tail densely hairy.

Number of segments 60.

Length 70 mm.

*Locality.* Porto Rico.

These two species, whether rightly or wrongly referred to the genus *Paraiulus* by *Bollman* I cannot say, may be easily separated as follows:—

- a. The repugnatorial pores situated in front of the transverse sulcus; anal tergite not surpassing the valves . . . . . *curiosus*.
- b. The repugnatorial pores situated behind the transverse sulcus; anal tergite caudate, surpassing the valves . . . . *cæsar*.

## Family CAMBALIDÆ.

[=Cambalinæ, *Bollman*.]

Genus NANNOLENE, *Bollman*, *Ann. New York Acad.* iv. p. 39;  
*Ent. Am.* ii. p. 225.

\*NANNOLENE CUBENSIS, *Bollman*, *Proc. U. S. Nat. Mus.* 1888,  
 p. 335.

"Brownish-blue, with the border of the segments brown; antennæ and legs light brown, an indistinct row of light spots on each side.

"Eyes composed of about 16 ocelli, arranged in three transverse rows. Antennæ and legs stouter than in the Californian species, from which *cubensis* further differs in that the circular depressions which mark the transverse sulcus on the terga are continued only up to the pore and not over the dorsum.

"Number of segments 47.

"*Locality*. Cuba."

NANNOLENE DOMINICANA (*Pocock*).

*Spirostreptus dominicanus*, *Pocock*, *Ann. Mag. Nat. Hist.* (6) ii.  
 pp. 478, 479, pl. xvi. fig. e.

*Colour* black or banded with fuscous; lower half of the head pale; antennæ and legs nearly white.

*Antennæ* short, shorter than the head, surpassing the collum. *Eyes* well developed, composed of about three transverse rows of well-defined ocelli. The posterior half of the segments distinctly higher than the anterior. The longitudinal striæ at the anterior extremity of the body reaching up to the pore, falling farther and farther short of it towards the hinder end. Pores conspicuous, beginning on the 5th segment, above the middle of the side. Sterna smooth.

*Locality*. Dominica (*G. A. Ramage*).

The above remarks are intended to supply deficiencies in my previous description of this species, which I erroneously referred to the genus *Spirostreptus*.

## Family SPIROSTREPTIDÆ.

[=Spirostreptinæ, *Bollman*, *loc. cit.*]

Genus SPIROSTREPTUS.

\*SPIROSTREPTUS VENTRALIS, *Porath*, *Bih. Sv. Vet.-Akad. Handl.* iv. no. 7, p. 42.

"Pale cinereous, posterior part of segments flavescent; legs and antennæ ochraceous.

"Slender, sublinear; head with sulcus obsolete; forehead rugulose anteriorly; four setigerous punctures over the labrum. Eyes composed of about 80 ocelli, arranged in 5 or 6 rows, separated by a distance equal to a diameter. Antennæ short. The lateral portion of the collum dilated inferiorly, so as to be lightly sinuate in front and behind; anterior angle rounded, posterior rectangular or subacute, with two complete sulci. Anal segment coriaceous, bluntly angled, valves marginate; sternite very widely angled. The rest of the segments finely coriaceous; the posterior part lightly striate almost up to the pores; sterna striate.

"Length 93 mm., width 5.

"Number of segments 55.

"*Locality.* St. Thomas."

\**SPIROSTREPTUS SCULPTURATUS*, *Karsch, op. cit.* p. 39.

♀. Slender, brown, collum flavo-limbate, posterior border of rings flavous, legs and antennæ testaceous; face smooth; collum laterally narrowed, its anterior lateral margin convex, posterior angle nearly rectangular, three marginal sulci forming flavous folds; segments deeply sulcate; the median and posterior part adorned with very fine close-set longitudinal sulci; laterally striate up to the pores; pores tolerably large, the sulci sinuate behind them; anal segment nearly smooth, shining, posteriorly widely rounded, scarcely angled; anal valves with lightly compressed margins; antennæ reaching the sixth ring.

Number of somites 58.

Length 55 mm.

*Locality.* Porto Rico.

\**SPIROSTREPTUS ABSTEMIUS*, *Karsch, op. cit.* p. 36.

"Slender, nearly black, legs and antennæ reddish brown; face very convex; sides of the collum widely rounded, bisulcate; rings deeply sulcate, nearly smooth, the posterior part sulcate beneath, above and at the sides very lightly longitudinally striolate and punctulate; anal tergite posteriorly roundly angled, valves convex, margins deeply and widely sulcate; antennæ reaching the third ring in female and surpassing it in male.

"Number of somites about 50."

*Locality.* ? Cuba.

\**SPIROSTREPTUS NITIDUS*, *Daday*, *Term. fuzetek*, xiv. p. 137, pl. vii. fig. 5.

"Colour: the posterior portion of the segments brownish black bordered with ferruginous, the anterior flavous; legs and antennæ fusco-brunneous.

"Body moderate, a little attenuate anteriorly and posteriorly.

"Head subrugose below, with four pores; a slender sulcus above. Antennæ a little surpassing the third segment; eyes composed of about 63 ocelli arranged in seven transverse series.

"First tergite laterally subtruncate, the anterior angle rectangular, the posterior nearly so, with four complete and one incomplete sulcus.

"Segments distinctly sulcate, the posterior portion densely punctulate above, sulcate below; the anterior portion transversely striate.

"Anal tergite not surpassing the valves; valves convex, compressed marginally. Pores very small, behind the sulcus.

"Number of segments 60-61.

"Length 130-135 mm., width 8-10 mm.

"*Locality*. Trinidad."

*SPIROSTREPTUS ANTILLANUS*, sp. n. (Pl. XXXVIII. figs. 1-1 *♂*.)

? *Sp. nitidus*, *Daday*, *cf. supra*.

*Colour* black or very deep chocolate-brown; the anterior border of the collum and the posterior border of the rest of the tergites very narrowly ferruginous; legs and antennæ fuscous, in ♂ ferruginous.

♀. *Head* rugulose below, smooth above.

*Eyes* separated by a space that is less than a diameter, internally acutely angled, composed of about six transverse rows of ocelli.

*Antennæ* a little longer than the face, just overlapping the 2nd segment. *First tergite* laterally tolerably evenly rounded, with a marginal sulcus and two other complete sulci, besides a varying number of shorter incomplete sulci.

The rest of the *segments* transversely striolate in front, closely and very finely punctulate behind, the transverse sulcus complete and marked with punctures. The longitudinal striæ extending about halfway up to the pore. *Sterna* smooth. *Pores* minute, well behind the sulcus.

*Anal tergite* posteriorly bluntly angled, not surpassing the

valves, marked with a transverse constriction. *Valves* convex, with strongly compressed margins. *Sternite* posteriorly angular, defined by a sulcus.

*Legs* with two, three, or more setæ on the lower surface of each segment.

♂. Face rather smoother than in the female, with the antennæ a little longer; legs with the penultimate and antepenultimate segments padded; anterior border of collum produced.

Copulatory feet as in fig. 1 *d*.

Number of segments: ♀, 60-63; ♂, 59-63.

♀, length up to 150 mm., width 9.5; ♂, length up to 70.

*Localities*. St. Thomas (in Brit. Mus.); Grenada (*H. H. Smith* and *Sherring*).

The following label accompanies some of Mr. Smith's specimens:—"Windward side, below 500 ft.; March-July. Common on logs, &c."

This species is unquestionably very nearly related to *Sp. nitidus* of Daday from Trinidad; but although no differential characters are mentioned in the description of this last-named form, it is, I think, wise to look upon the two as provisionally distinct, at least until the male of the Trinidad form comes to light and settles the point.

*Sp. antillanus* may be recognized from *Sp. ventralis* by its smooth sterna; from *Sp. sculpturatus* by the absence of sulcate sculpturing on the dorsum, by its shorter antennæ, different colour, &c.; and from *Sp. abstemius* also by the sculpturing, difference in the number of segments, &c.

#### Family SPIROBOLIDÆ.

[=Spirobolinæ of *Bollman*, *loc. cit.*; Spirobolidæ (in part), *Verhoeff*, *Zool. Anz.* xvi. p. 481, 1893.]

The West-Indian species of this family fall into the following four genera:—

- a*. Labral pores 3 to 5 on each side; first tergite laterally narrowed; no scobina ..... SPIROBOLUS, Br. (s. s.).  
Type, *Bungii*, Brandt.
- b*. Labral pores 2+2.
  - a*<sup>1</sup>. First tergite laterally acutely angled; no scobina ..... TRIGONIULUS, nov.  
Type, *Goësi*, Por.



*b*<sup>1</sup>. First tergite widely rounded; scobina generally present.

*a*<sup>2</sup>. Anal somite normally constructed . . . . RHINOCRICUS, Karsch.  
Type, *parcus*, Karsch.

*b*<sup>2</sup>. Anal valves closing nearly transversely;  
the sternite enormously thickened. . . . THYROPROCTUS, nov.  
Type, *Townsendi*, sp. n.

### Genus SPIROBOLUS.

\*SPIROBOLUS MULTIF[P]ORUS, *Karsch, op. cit.* p. 58.

"Colour fusco-brunneous, the collum, antennæ, legs, posterior margin of the segments, and the anal valves pale brown.

"Small and slender.

"Head smooth; pores 4+4 or 5+5; antennæ not surpassing the collum.

"Collum laterally narrowed, widely rounded, almost touching the margins of the second segment, with a marginal sulcus. Segments very smooth; the sulcus obsolete dorsally; the anterior portion smooth, the posterior longitudinally sulcate beneath. Pores large, only just in front of the sulcus, above the middle of the side. Anal tergite subacute posteriorly, scarcely surpassing the convex valves.

"Number of segments 39.

"Length of body 25 mm.

"*Locality.* Porto Rico."

### Genus TRIGONIULUS.

TRIGONIULUS GOËSI (*Porath*).

*Spirobolus* Goësi, *Porath, Bih. Sv.-Vet. Akad. Handl.* iv. no. 7, p. 36;  
*id. Ann. Soc. Ent. Belg.* xxxii. p. 244.

*S. dominicæ*, *Pocock, Ann. Mag. Nat. Hist.* (6) ii. pp. 481-483,  
pl. xvi. fig. 7.

? *S. sanctæ-luciæ*, *Bollman, Proc. U. S. Nat. Mus.* 1888, p. 214.

The British Museum has examples of this widespread tropical species from Hayti and Dominica. *Porath* has recorded it from St. Bartholomew, and the type of *Bollman's* species was from St. Lucia. This species, which has been intelligibly described in the papers mentioned in the above list, may be always recognized by its uniform earthy or brick-red colour, its laterally-narrowed collum, and its characteristic sculpturing, which takes the form of a network of crescentic or subcircular striæ.

## Genus RHINOCRICUS.

*Synopsis of the Species.*

- a.* Anterior border of the segments not furnished with circular or crescentic impressions (scobina).
- a*<sup>1</sup>. The anal tergite acutely angled behind; the transverse sulcus complete dorsally; black, with median dorsal series of pale spots. . . . . *Ramagei*, sp. n.
- b*<sup>1</sup>. The anal tergite bluntly rounded behind.
- a*<sup>2</sup>. The transverse sulcus deep and complete dorsally . . . . . *mandevillei*, sp. n.
- b*<sup>2</sup>. The transverse sulcus obsolete or very weak dorsally.
- a*<sup>3</sup>. Collum with strongly marginate border . . *politus*, Por.
- b*<sup>3</sup>. Collum with border scarcely marginate . . *Gossei*, sp. n.  
*Townsendi*, sp. n.
- b.* Anterior border of some of the segments furnished with scobina.
- a*<sup>4</sup>. Clypeus very deeply excised . . . . . *excisus*, Karsch.
- b*<sup>4</sup>. Clypeus lightly and normally excised.
- a*<sup>5</sup>. The segments not furnished with a second transverse groove in front of the ordinary sulcus (not always strictly true of *arboreus*).
- a*<sup>6</sup>. The posterior border of the segments above the scobina bisinuate; no caudal process.
- a*<sup>7</sup>. Pores scarcely above the middle of the side; scobina reaching only to the 12th segment . . . . . *parcus*, Karsch.
- b*<sup>7</sup>. Pores well above the middle of the side; scobina reaching to the 24th segment . . . . . *holomelanus*, sp. n.
- b*<sup>6</sup>. The posterior border of the tergites not bisinuate.
- a*<sup>8</sup>. The anal tergite not produced into a process surpassing the valves.
- a*<sup>9</sup>. Species of large size, from 75-163 mm. in length, and with from 47-54 segments.
- a*<sup>10</sup>. Antennæ long, reaching the 3rd segment . . . . . *domingensis*, Sauss.
- b*<sup>10</sup>. Antennæ short, scarcely surpassing the collum . . . . . *Maltzani*, sp. n.  
Probably also *haitensis*  
and *Duvernoyi*.

- b*<sup>9</sup>. Species of small size, less than 40 mm. in length, and with fewer than 47 segments ..... *solitarius*, sp. n.
- b*<sup>3</sup>. The anal tergite surpassing the valves.
- a*<sup>11</sup>. Caudal process short, segments 40-42.
- a*<sup>12</sup>. Legs long, antennæ reaching the fourth ring ..... *gracilipes*, Karsch.
- b*<sup>12</sup>. Legs short, antennæ not reaching the fourth ring. .... *grenadensis*, sp. n.
- b*<sup>11</sup>. Caudal process long; segments over 50; legs very long.
- a*<sup>13</sup>. Posterior part of the segments not elevated ..... *arboreus*, Sauss.
- b*<sup>13</sup>. Posterior part of segments elevated ..... *macropus*, sp. n.
- b*<sup>5</sup>. The area of the dorsum in front of the transverse sulcus, or in front of its position when obsolete, crossed by a second sulcus.
- a*<sup>14</sup>. The posterior transverse sulcus complete dorsally, at least on the segments in the middle of the body.
- a*<sup>15</sup>. The anterior transverse sulcus weak and often interrupted, the posterior weaker; anal tergite not surpassing the valves, and not acutely produced; black with brown legs. .... *leptopus*, sp. n.
- b*<sup>15</sup>. The two transverse sulci complete and deep on nearly all the segments; anal tergite produced into a narrower or wider caudal process, which surpasses the valves.
- a*<sup>16</sup>. The anterior transverse sulcus rising on each side from the lateral portion of the posterior sulcus considerably below the pore; colour black, with a median dorsal flavous spot, and a lateral flavous spot on the pore . . . *leucostigma*, sp. n.
- b*<sup>16</sup>. The anterior transverse sulcus rising on each side in front of and on a level with the pore; the segments distinctly flavo- or ferrugino-cingulate.
- a*<sup>17</sup>. Caudal process considerably surpassing the valves, the area of the segments behind the posterior sulcus flavous ..... *monilicornis*, Por.

- b*<sup>17</sup>. Caudal process scarcely if at all surpassing the valves; only the posterior border of the segments ferruginous ..... *consociatus*, sp. n.
- b*<sup>14</sup>. The posterior transverse sulcus obsolete dorsally on all or most of the segments.
- a*<sup>18</sup>. Anal tergite acutely angled posteriorly.
- a*<sup>19</sup>. The transverse sulcus conspicuous laterally; colour as in *monilicornis*; flavo-cingulate ..... *anguinus*, sp. n.
- b*<sup>19</sup>. The transverse sulcus obsolete or nearly so on most of the segments; the upper surface of the segments dark, with a flavous spot on each side of the middle line.
- a*<sup>20</sup>. Segments 48-52; colour less pronounced ..... *serpentinus*, sp. n.
- b*<sup>20</sup>. Segments 40-43 ..... *grammostictus*, sp. n.
- b*<sup>18</sup>. Anal tergite not acutely produced.
- a*<sup>21</sup>. The posterior portion of the segments flavo- or ferrugino-cingulate.
- a*<sup>22</sup>. The segments distinctly punctulate or striolate; anal segment black ..... *vincentii*, sp. n.
- b*<sup>22</sup>. The segments smooth and polished, at least dorsally; anal segment flavous or lurid ..... *Cockerellii*, sp. n.
- b*<sup>21</sup>. The segments ornamented with a median dorsal black band and a second black band on each side on a level with the pore ..... *sabulosus*, sp. n.

\*RHINOCRICUS POLITUS, *Porath, Ann. Soc. Ent. Belg.* xxxii. p. 243.

"Colour fusco-olivaceous, the posterior border of the segments narrowly pale; feet and antennæ pale.

"Head nearly smooth; sulcus mesially interrupted; pores 2+2; eyes rounded, composed of about 35 ocelli, separated by a space equal to about three diameters. Antennæ short, scarcely reaching the margin of the collum.

"Collum with widely-rounded lateral portion, thickly margined. The following segments dorsally and laterally very smooth and polished, striolate inferiorly above the legs; sterna striate, transverse sulcus distinct only above the legs, obsolete laterally and

above. *Pores* large, in the anterior part of the segment, above the middle of the side, the first lower than the rest. The anal tergite posteriorly widely and obtusely angled, not surpassing the valves; valves compressed; margins lightly reflexed, sternite apically rounded. *Legs* short, with a single seta below each segment.

"Number of segments 46.

"Length 77 mm., width 8.

"*Locality*. Antigua."

*RHINOCRICUS RAMAGEI*, sp. n.

*Colour* black or slate-grey, with a pale spot in the middle of the dorsum; the posterior border of the somites is inferiorly obscurely ferruginous; antennæ fuscous; legs flavous.

*Body* short and robust.

*Head*: antennæ, collum, &c. normally constructed, but the eyes much less clearly defined.

The segments smooth, at most minutely punctulate, the longitudinal striolæ scarcely extending at all up the sides of the body; the anterior portion scarcely sculptured, the sulcus weak but complete, except at the hinder end of the body, without a stria or sulcus in front of it; pores minute, situated above the middle of the side behind, but in a distinct fold of the sulcus; sterna striate. *Scobina* absent.

*Anal somite* small; tergite somewhat acutely angled, covering but not surpassing the valves; the valves lightly compressed posteriorly but not marginate; sternite triangular.

*Legs* longish, those at the anterior end of the body with the basal two segments carinate and compressed.

Number of segments 44.

Length about 50 mm., width 5.5 mm.

*Locality*. St. Lucia (*G. A. Ramage*).

A single female example.

In the absence of the scobina this species resembles *R. Gossei* and *R. politus*; it may be recognized from both, however, by its acutely-angled anal tergite and complete transverse sulcus.

*RHINOCRICUS MANDEVILLEI*, sp. n.

*Colour* dark brown or nearly black, with the area of the segments behind the transverse sulcus widely and completely flavous; head flavous, lightly infuscate; antennæ and legs flavous; valves ochraceous; anal tergite fuscous.

*Head* smooth; pores 2+2; antennæ short; eyes very widely separated; collum laterally rounded.

*Segments* with complete and strong transverse sulcus; the area behind it slightly elevated, almost entirely smooth; strongly striate below; no stria in front of the sulcus. *Scobina* absent. *Pores* conspicuous, just in front of the sulcus, but in a loop of it. *Sterna* striate. *Anal tergite* obtusely angled behind, not surpassing the valves; valves convex and not compressed; sternite triangular.

*Legs* short, with one seta beneath the segments.

Number of segments 40-42.

Length up to 33 mm., width 4 mm.

*Locality.* Mandeville, Jamaica, 1950 feet alt. (*T. D. Cockerell*).

Of the species enumerated in this paper, *R. mandevillei* is allied to *R. Ramagei* in being without the scobina and without a stria in front of the complete transverse sulcus. The two forms, however, differ strongly in colouring, and in *R. Ramagei* the anal tergite is acutely angled behind.

RHINOCRICUS GOSSEI, sp. n. (Pl. XXXVIII. fig. 2.)

*Colour* (dry example) mostly pale greenish yellow, the area of the tergites behind the sulcus ferruginous (probably olivaceous or nearly black and banded with red when fresh); antennæ and legs pale, but showing signs of infuscation.

*Head* smooth, polished, the sulcus weak; labral pores 2+2. *Antennæ* very short, shorter than the face and not extending to the hinder border of the collum. *Eyes* consisting of about 33 ocelli arranged in about 6 transverse series, the ocelli not contiguous; distance between the eyes greater than four diameters.

*Collum* smooth above, evenly rounded at the sides, with a faint marginal sulcus, not extending so low as the second tergite; second tergite flat beneath. The rest of the tergites smooth above and at the sides, the longitudinal sulci extending only a very short distance up the side; the transverse sulcus complete or obsolete above; the pores situated just in front of it. *Scobina* apparently absent\*.

*Anal somite* short; the tergite produced into a rounded angular process which covers but does not project beyond the valves; margin of valves compressed or scarcely at all compressed; sternite triangular, the apex more or less rounded.

\* At least, it is not present upon the 11th and 18th segments.

*Legs* short, with a single seta below each segment.

Number of somites 44-47.

Length 55-60 mm.

♂ more slender than ♀, the anterior coxæ not or scarcely produced.

*Locality.* Jamaica (*P. H. Gosse*).

This species is very closely allied to *R. politus* of Porath, but seems to differ at least in having the collum scarcely margined. In *politus* this plate is described as thickly and deeply marginate.

\**RHINOCRICUS EXCISUS*, *Karsch, op. cit.* p. 73.

*Colour* black, concolorous.

*Robust.*

*Head* marked with transverse striæ; labral border so deeply excavated that the excision extends as far as the insertion of the antennæ. Pores 2+2. *Antennæ* not surpassing the collum.

*Collum* widely rounded, without marginal sulcus.

*Segments* not visibly sulcate, smooth, sulcate or striate beneath. *Scobina* extending to the 26th or 27th rings. *Pores* large, above the middle of the side, in front of the transverse sulcus and marked by a longitudinal sulcus.

*Anal tergite* with its angle rounded, not surpassing the valves, which have their margins widely compressed.

Number of segments 53.

Length up to 140 mm.

*Locality.* Jamaica.

\**RHINOCRICUS PARCUS*, *Karsch, op. cit.* p. 68.

*Colour* fusco-testaceous; antennæ and legs red.

*Body* tolerably thick.

*Head* smooth, its sulcus interrupted; pores 2+2; antennæ not surpassing the collum.

*Collum* laterally rounded. The segments not visibly sulcate, smooth, the anterior part adorned beneath with abbreviated transverse striæ; dorsum smooth. *Scobina* on segments 8-12, the posterior margin of segments 7-11 deeply excised; the median and posterior part of the posterior segments more or less evidently canaliculate; pores large, scarcely above the middle of the side, in front of the sulcus.

*Anal tergite* with its posterior angle rounded, not touching the margin of the valves; valves convex, compressed, not marginate.

Number of segments 43.

Length: ♂, 115 mm.; ♀, 80 mm.

*Locality.* Porto Rico.

*RHINOCRICUS HOLOMELANUS*, sp. n.

? *Spirobolus excisus*, *Karsch, Zeits. Naturwiss.* (3) vi. p. 73.

*Colour* black, shining; antennæ and legs of the same colour.

Face mesially impressed, striolate, frontal sulcus deep; labral sulcus shallow; labrum with 2+2 pores, normally emarginate. *Antennæ* not surpassing the collum. *Eyes* very indistinct, separated by a space equal to about three diameters.

*Collum* laterally rounded, without marginal sulcus. The rest of the segments smooth, at most lightly wrinkled longitudinally, striate only inferiorly; the transverse sulcus very feeble, almost obsolete both laterally and above. *Sterna* transversely striate. *Scobina* very deep and large, extending to the 24th or 25th segment, the posterior border of more or fewer of the anterior scobinate segments lightly bi-emarginate. *Pores* very conspicuous, far above the middle of the side, just in front of the transverse sulcus, the first below the level of the rest. *Anal tergite* bluntly angled behind, not surpassing the valves; valves with lightly compressed margins; sternite large, posteriorly rounded.

*Legs* short, the segments furnished beneath with a single seta.

Number of segments 51.

Length up to 105 mm.

*Locality.* Jamaica.

Of this species I have seen three female examples, one adult and one young received from Mr. T. D. A. Cockerell, who obtained them at Moneague and Mandeville, and one dried example presented by Mr. P. H. Gosse.

In the young specimen the emargination of the tergite is more pronounced than in the adult, and the legs are ferruginous. The specimen sent by Mr. P. H. Gosse is, owing to its method of preservation, of a ferruginous colour.

Judging by Dr. Karsch's description of *R. excisus*, the latter is very nearly related to this new form. There are, however, noticeably two points in which it differs, namely, in having the labrum very deeply emarginate and the posterior border of the segments not bisinuate. The last, however, is a variable character and is only doubtfully valuable for distinguishing species.



*RHINOCRICUS MACROPUS*, sp. n. (Pl. XXXVIII. figs. 3-3 d.)

♀. *Colour* almost black, or a deep brownish black, tinted with olive-green; legs green or piceous, with the tarsal segment ferruginous.

*Head* smooth, obsoletely transversely striolate or wrinkled; the sulcus interrupted in several places; two labral pores on each side. *Antennæ* reaching the hinder border of the collum, about as long as the face. *Eyes* separated by a space that is about equal to two diameters, composed of about 33 ocelli arranged in about six transverse rows. *Collum* smooth, evenly rounded laterally, and not extending so low as the second tergite, with a marginal sulcus. Second tergite flat beneath, with the rest of the somites smooth above, the posterior half polished and elevated. The transverse sulcus has the form of a shallow groove. The *pores* minute, situated just in front of the sulcus. The *striae* extending up to the pore, and, in the anterior segments, from the pore a transverse stria extends over the dorsum in front of the transverse sulcus. *Scobina* present but very small, extending to about the 35th segment. *Sterna* transversely striolate. *Anal somite* small, the tergite produced into a wide, long, angular caudal process, which far surpasses the valves. *Valves* with margins lightly compressed. *Sternite* triangular. *Legs* very long and slender, with a single seta on the lower edge of each segment.

♂. A little slenderer than the female. The anterior legs swollen and padded beneath, the coxæ produced and the trochanter bearing a distinct tubercle at its distal end. The gnathochilarium with a conspicuous tubercle on each side near its free edge.

Copulatory feet as in fig. 3 d.

Number of segments 50-51.

♀. Length about 93 mm., width 8.8 mm.

♂.     "     "     88 mm.,     "     8.0 mm.

*Locality.* St. Vincent (*H. H. Smith*). "Pretty common in the mountain forest, up to 2000-3000 ft."

*RHINOCRICUS ARBOREUS*, *Sauss. Linn. Ent.* xiii. p. 331 (1859); *Mém. Mex., Myriop.* p. 98, pl. iv. fig. 28. (Pl. XXXVIII. fig. 4.)

This species is very closely related to the preceding in the length of its legs, small scobina, long wide tail, size, colouring, &c. It may be recognized, however, by the form of its copulatory

feet. Moreover, the posterior portion of the tergite is not elevated and the transverse sulcus is continued over the dorsum as a distinct stria. In the male the anterior legs are much less swollen than in *R. macropus*.

Number of segments up to 54.

Length up to 94 mm. (78 according to de Saussure).

*Locality*. St. Thomas (*M. Sallé coll.*); Santa Cruz (*A. Newton*); Antigua.

Dr. Karsch (Zeits. Naturwiss. (3) vi. pp. 8-9) has recorded this species from Porto Rico. He characterizes two varieties of it in the following terms:—Var. *Krugii*. "Black with reddish border to the rings and reddish legs: western part of island." Var. *Gundlachi*. "Greyish form, with dorsal red spot on the rings and orange-coloured tarsi: centre of island and ? east coast."

The colour of the typical form, of which the Museum has a great number of alcohol-examples from St. Thomas, is usually a greyish greenish black, the posterior third of the rings being much darker and bordered with reddish; the legs are greyish green and concolorous. The specimens from Santa Cruz and Antigua resemble those from St. Thomas.

Some authors have suggested that this species is identical with *Rh. caudatus* of Newport. There is, however, but little resemblance between the two.

\**RHINOCRICUS HAITENSIS* (*Gervais*), *Ins. Aptères*, iv. pp. 191-192; *Voyage de Castelnau, Myriapodes*, p. 23, pl. iii. fig. 1 (1859).

Colour black, including the head and antennæ.

Eyes arranged in a suborbicular patch, consisting of six rows of ocelli. Labral punctures 2+2; the median cephalic sulcus feebly indicated. The first tergite triangular, rounded at apex, with a feeble marginal sulcus.

The inferior striæ on the rest of the segments very feebly developed; a few transverse striæ on the anterior part.

Anal tergite triangular, not spined, transversely impressed; not reaching the border of the valves; anal sternite triangularly rounded.

Number of segments 54.

Length 163 mm., width 13 mm.

*Locality*. St. Domingo (Haiti).

This species is known to me only from the figure and description published by Gervais.

\**RHINOCRICUS DOMINGENSIS* (Sauss.).

*Spirobolus haitensis*, Sauss. *Mém. Mex., Myriap.* p. 105 (nec *haitensis*, Gerv.).

Colour blackish; testaceous when dry, with the posterior border of the segments reddish or fulvous.

*Body* cylindrical throughout, compressed posteriorly. Labral pores 2+2. *Eyes* forming a subtriangular plate disposed in five and seven rows.

*Antennæ* long, reaching the third somite. The first segment laterally rounded, with a feeble marginal sulcus. The second segment with its inferior angles not produced. All the segments very smooth, feebly striate below; the transverse sulcus very feeble, almost absent. *Pores* just above the middle of the side of the body.

*Anal tergite* angular, overlapped by the valves, both finely sculptured; *sternite* rounded.

♂. Legs 3-7 with their coxæ swollen.

The anterior lamina of the copulatory feet triangular, with rounded apex.

Number of segments 47.

Length 90 mm., width 9 mm.

*Locality.* St. Domingo (Haiti).

*RHINOCRICUS MALTZANI*, sp. n. (Pl. XXXVIII. figs. 5-5 b.)

Allied to the preceding.

*Colour* (in alcohol) a deep olive-green, sometimes nearly black, the posterior border of the tergites flavous or ferruginous, the pale band widening laterally and inferiorly. *Antennæ* and legs ferruginous or flavous, rarely piceous, as also are the edges of the valves and the margin of the labrum.

*Head* smooth, obsoletely striolate transversely; the sulcus obsolete mesially. Labral pores 2+2. *Antennæ* shorter than the face, not reaching the second tergite. *Eyes* separated by a space equal to more than three diameters. *First tergite* evenly rounded laterally, with a marginal sulcus, not extending inferiorly so low as the second. The second somite not excavated beneath. The rest of the somites almost without sculpture, striate immediately above the legs. The transverse sulcus not deep, nearly obsolete above; the area behind it polished, that in front of it dull. The *pores* situated high on the side, just in front of and touching the sulcus. *Scobina* small, extending to

about the 22nd somite. Anal somite moderate in size; the tergite transversely impressed above, not surpassing the valves; the valves with their margins a little or scarcely compressed; sternite triangular. Legs short, with a single seta on the lower edge of each segment.

♂. Anterior legs thickened; coxæ enlarged, especially those of the sixth pair.

Copulatory feet as in fig. 5 *a*.

Number of segments 50-52.

Length up to about 75 mm., width 7.8 mm.

*Locality*. Cape Haiti in St. Domingo.

This species appears to differ from the preceding two, which inhabit the same island.

*R. domingensis* differs from it in having longer antennæ and a differently formed copulatory apparatus; while *R. haitensis*, in addition to being much larger and differently coloured, seems to have the lateral border of the collum much narrower and more angular.

\*RHINOCRICUS DUVERNOYI, *Karsch, op. cit.* p. 77.

*Colour* brown, shining.

*Head* smooth; sulcus almost complete; labral pores 2+2.

*Collum* laterally rounded, nearly attaining the edge of the 2nd segment, not noticeably sulcate.

*Segments* with complete sulcus, smooth, posteriorly subcanalicate longitudinally; inferiorly striate. *Scobina* extending from the 8th to the 20th. *Pores* large, in front of the sulcus, the first much deeper than the others. *Anal tergite* submucronate, the base of the angle transversely grooved, not surpassing the valves, which are compressed and have thickened sulcate margins.

Number of segments 50.

Length 135 mm.

*Locality*. Cuba.

RHINOCRICUS SOLITARIUS, sp. n. (Pl. XXXVIII. fig. 6.)

♂. *Colour* (in alcohol) black, with red anal valves, red posterior borders to the somites, and yellow legs.

*Head* smooth, finely striate transversely, the median sulcus interrupted; labral pores 2+2. *Eyes* separated by a space equal to at least three diameters, consisting of about 30 ocelli arranged in six transverse series; *antennæ* very short, about

half the length of the head, and not extending beyond the collum.

*First tergite* nearly smooth, at most very finely punctulate; very widely rounded laterally, with a conspicuous marginal sulcus. *Second tergite* flat below or even a little excavated. The rest of the somites very finely transversely striolate in front; the inferior part above the legs longitudinally striolate, the striae in front of the transverse sulcus being directed obliquely upwards; the transverse sulcus visible inferiorly, becoming obsolete above and losing itself in a shallow transverse depression, which separates the anterior dorsal part from the posterior dorsal part of the somite; the dorsal part finely punctulate or minutely striolate. *Sterna* transversely striate. *Scobina* extending to about the 23rd somite. *Pores* conspicuous, situated above the middle of the side in a line with the sulci, the sulci, however, curve round them posteriorly; there is, moreover, a faintly marked stria running from the pore backwards to the hinder border of the somite. *Anal somite* small; tergite obtusely and roundly angled, not projecting beyond the summit of the valves; valves lightly compressed, with margins simple; sternite more than twice as wide as long, with convex posterior border.

*Legs* short and thick, with a single seta below each segment; those at the anterior end of the body thickened, with the coxae slightly produced.

The anterior median lamina of the copulatory feet flat, narrowed inferiorly, with lightly sinuate sides, the apex widely rounded, the anterior lateral laminae not extending inferiorly so low as the median, but surpassed by the posterior lateral.

Number of segments 44.

Length about 32 mm.

*Locality.* Jamaica (*T. D. A. Cockerell*).

\**RHINOCRICUS GRACILIPES*, *Karsch, op. cit.* p. 71.

*Colour* blackish.

*Body* slender.

*Head* without sulcus, slightly roughened with oblique striae; labral pores 2+2. *Antennae* long, reaching the fourth ring.

*Collum* irregularly rugose, widely rounded laterally. Segments deeply segmentate; scobina extending to about the 29th segment; the posterior part of the segments irregularly longitudinally

subcostate, striate beneath; the anterior part smooth above, striolate below.

*Pores* small, nearly in the middle, in front of the transverse sulcus and at the anterior extremity of a longitudinal sulcus.

Anal tergite produced into a depressed caudal process, which surpasses the valves a little; valves with widely compressed margins.

Legs very long.

Number of segments 40-42.

Length 60 mm.

*Locality.* Cuba.

RHINOCRICUS GRENADENSIS, sp. n. (Pl. XXXVIII. fig. 11.)

*Colour* somewhat variable; the body usually nearly a uniform fuscous anteriorly, but generally richly mottled with black and yellow posteriorly, rarely almost entirely concolorous, with the posterior part of the segments paler than the anterior; the collum entirely bordered with a paler band, anal segment and sulcus black; face infusate, with a darker patch in the middle; legs and antennæ flavous.

*Head*, as usual, smooth or nearly so, pores 2+2; antennæ short; eyes with indistinctly defined ocelli, widely separated. *Collum* evenly rounded laterally, with a faint marginal sulcus. The rest of the segments shining, nearly smooth, minutely striolate. The transverse sulcus very strong below, and continued over the dorsum as a distinct depression; the area behind it longitudinally sulcate below, that in front of it obliquely striate below, but none of these striæ are continued above the level of the pore, so that there is no secondary transverse dorsal sulcus. *Scobina* present and extending to about the 27th segment.

*Sterna* striate. *Pores* above the middle of the side, just in front of the sulcus; their position marked by a faint longitudinal sulcus upon the posterior portion of the segment.

*Anal tergite* just surpassing the valves, the caudal process bluntly rounded and basally impressed; the valves lightly compressed, but the margins not sulcate; sternite triangular.

*Legs* of moderate size, with a single seta on the lower edge of each segment.

♂. More slender than the female, antennæ extending beyond the second segment, the legs rather longer. Some of the

anterior legs thickened, and with their basal segments inferiorly subcarinate. The anterior lamina of the copulatory foot evenly cordate.

Number of segments about 40-42.

♀. Length up to 36 mm., width 4 mm.

♂. " " 31 mm., " 3 mm.

*Locality.* Grenada (*H. H. Smith*).

*RHINOCRICUS MONILICORNIS* (*Porath*).

*Spirobolus monilicornis*, *Porath, Bih. Sv. Vet.-Akad. Handl.* iv. no. 7, p. 31 (1876).

*Spirobolus* Heilprini, *Bollman, P. Ac. Philad.* 1889, p. 127.

? *Spirobolus virescens*, *Daday, Term.fusetek*, xiv. p. 140, pl. vii. figs. 8-10.

*Colour* greenish black, with the hinder border of the segments widely flavous or ferruginous; collum entirely bordered with same pale colour; antennæ, feet, and caudal process also flavous or ferruginous.

*Body* tolerably slender.

*Head* with nearly complete sulcus; pores 2+2. *Antennæ* short, scarcely reaching the border of the collum. *Eyes* distinct, suborbicular, separated by a space greater than two diameters.

*Collum* laterally widely rounded, lightly marginate.

*Second segment* not excavated beneath. The rest of the segments transversely bisulcate above; the ordinary sulcus complete, and in front of it a second sulcus, which takes its origin on a level with the pores. The anterior part of the segments strigose, the posterior part striolate below, the striolæ becoming shorter towards the dorsum.

The *pores* small, situated just behind, but in a loop of the sulcus; sterna transversely striate.

*Scobina* present.

*Anal tergite* produced into an acutely angled process, which projects beyond the summit of the anal valves; *valves* compressed, not marginate; sternite angled.

*Legs* short.

♂. Coxa of the 3rd, 4th, and 5th legs produced into a conspicuous triangular process.

Copulatory feet almost exactly as in the following species.

Number of segments 44-45 in male, 48 in female.

Length up to about 45 mm.

*Locality.* Barbadoes (*H. W. Feilden*); Cape Hayti.

I can find no valid reason for separating *R. monilicornis* from *R. Heilprini*.

The species seems to be tolerably widely spread. *R. monilicornis* was recorded from Brazil and *R. Heilprini* from Bermuda. In addition to the specimens already mentioned from Barbadoes, the British Museum has others, all apparently co-specific, from Georgetown, Demerara (*J. J. Quelch*), and Bermuda ('*Challenger*').

*RHINOCRICUS CONSOCIATUS*, sp. n. (Pl. XXXVIII. fig. 7.)

Closely allied to the preceding.

*Colour* much darker; segments black, with the hinder border only flavous or ferruginous, and only about the posterior third of the anal tergite pale coloured; antennæ and legs lurid. The transverse sulcus complete dorsally on all the segments, except the first and last; the second sulcus always clearly defined in front of it, so that each segment is evidently transversely bisulcate dorsally.

In the male the coxæ of the 3rd-5th legs are much less noticeably enlarged than in *R. monilicornis*, and the legs of the rest of the body are considerably larger—*i. e.* they are about as long as the face.

Number of segments 44.

Length up to 35 mm., width 3 mm.

*Locality.* Union Island.

*RHINOCRICUS LEUCOSTIGMA*, sp. n. (Pl. XXXVIII. fig. 8.)

*Spirobolus paraensis*, *Pocock, Ann. Mag. Nat. Hist.* (6) ii. p. 479 (*not paraensis of Humb. & Sauss.*).

Allied to *R. monilicornis*.

*Colour* black; a flavous spot marking each pore and a large fulvous spot upon the middle of the dorsal surface on the anterior half of the segments; legs and antennæ flavous or fulvous; anal valves posteriorly ferruginous; sterna fulvous.

*Head* transversely striolate; pores 2+2. *Eyes* large, orbicular, separated by a space about equal to three diameters. *Antennæ* just surpassing the collum.

*Collum* evenly rounded laterally, with a marginal sulcus; the rest of the segments smooth above; the vertex crossed by two sulci as in *monilicornis*, but the anterior sulcus rises some distance below the pore; the area in front of the main sulcus obliquely



striolate at the sides and below, the area behind longitudinally striate below; the scobina small, but extending at least to the 20th segment; sterna striate.

*Pores* situated in front of the sulcus, but in a fold of it.

*Anal tergite* produced into an acutely angular, blunt process, which just surpasses the valves; valves with margins strongly compressed; *sternite* triangular.

*Legs* short, with a single seta below each segment.

♂. Thinner than the female and with longer legs; the coxæ of the anterior legs slightly produced.

Number of segments about 44.

Length of male and female about 50 mm., width of male 4, of female 4.3 mm.

*Locality.* Dominica (*G. A. Ramage*).

#### RHINOCRICUS GRAMMOSTICTUS, sp. n.

*Colour* very much as in *R. serpentinus*, but more pronounced, the median dorsal dark band and the two dorsal flavous bands being more clearly defined. The *segments* nearly smooth, minutely punctulate, with scarcely a trace of the transverse sulcus, the posterior portion weakly striate longitudinally below, the anterior portion adorned with obliquely set short striolæ about up to the pore; the pore minute, isolated, the sulcus obliterated near it, with a transverse striola crossing the dorsum in front of the position of the pore, this stria becoming fainter towards the hinder extremity of the body. *Sterna* striate. *Scobina* present. The posterior segments obsoletely wrinkled longitudinally. *Anal somite* small, the tergite produced into an acute process, which projects beyond the summit of the valves; valves slightly compressed, not marginate.

*Legs* short, the basal segments of the anterior ones compressed and carinate.

Number of segments 40-43.

Length up to 45 mm., width 4.5 mm.

*Locality.* St. Lucia (*G. A. Ramage*).

Although resembling *R. serpentinus* very closely in colouring, this species may be recognized by its more robust build, fewer segments, longer tail, &c.

#### RHINOCRICUS SERPENTINUS, sp. n. (Pl. XXXVIII. fig. 9.)

*Colour* variable, slate-grey above, with a yellow spot on each

side of the middle line, which is deep black; the dark colour of the dorsal surface generally fading into flavous at the sides; legs bright flavous; antennæ fusco-annulate.

*Head* smooth, pores 2+2, sulcus mesially interrupted; *eyes* orbicular, separated by about four diameters; *antennæ* short, scarcely surpassing the collum.

*Collum* laterally rounded, with a weak marginal sulcus; the rest of the segments smooth behind, the transverse sulcus obsolete or nearly so dorsally; a transverse sulcus in front of it, rising on a level with the pores, as in *R. monilicornis*, but weaker, and sometimes incomplete mesially; the area in front of this secondary sulcus adorned with many shorter fine transverse or oblique sulci, which below are continuous with the longitudinal sulci of the posterior portion of the segments. *Pores* small, situated in front of the position of the normal sulcus.

*Sterna* striate. *Scobina* extending at least to the 30th segment.

*Anal somite* compressed; tergite produced into an angular process which does not surpass the valves. *Sternite* triangular; valves lightly but widely depressed.

*Legs* as in *R. monilicornis*.

Number of segments 48-52.

♀. Length up to 62 mm., width 5.0 mm.

♂.    "       "    60 mm.,    "    4.5 mm.

*Locality.* St. Lucia (Fond de Jacques).

Collected by G. A. Ramage.

#### RHINOCRICUS ANGUINUS, sp. n.

Closely allied to *R. serpentinus*.

*Colour* almost exactly as in *R. monilicornis*, the segments being piceo-olivaceous and posteriorly widely bordered with pale olivaceous, the anal tergite, however, is only narrowly bordered with flavous, while the valves are more widely flavous posteriorly. On the segments, the transverse sulcus is almost entirely obsolete dorsally and not deep as in *R. monilicornis*; the sulcus in front of it, however, is distinct, and rises from the level of the pore; the area in front of the sulci is adorned with transversely or obliquely set short striolæ above and at the sides.

The *anal somite* is small; the tergite acutely angled, but scarcely covering, and certainly not surpassing the valves.

Sexual characters as in *R. monilicornis*.

Number of segments 50.

Length 51 mm.

*Locality.* A single male from St. Lucia (*G. A. Ramage*).

Differs from *R. monilicornis* in that the sulcus of the segments is incomplete dorsally, &c. In this respect it apparently resembles *R. flavo-cingulatus* of Karsch from Caraccas, but the two may certainly be distinguished by the shortness of the caudal process in this species.

*RHINOCRICUS LEPTOPUS*, sp. n.

Closely allied to *R. serpentinus*.

*Colour* entirely black. *Legs* fusco-ochraceous.

*Body* long and slender.

The transverse sulcus complete, except on the posterior segments, where it disappears; the posterior part of the segments longitudinally striate inferiorly, the anterior part obliquely and transversely striolate, a conspicuous stria rising about on a level with the pore, crossing the vertex from side to side.

*Scobina* present. *Anal segment* as in *R. serpentinus*.

*Legs* much longer than in *R. serpentinus*.

Number of segments 49.

Length 53 mm., width 4.5 mm.

*Locality.* St. Lucia (*G. A. Ramage*).

A single female example.

*RHINOCRICUS VINCENTII*, sp. n. (Pl. XXXVIII. fig. 10.)

♀. Short and robust.

*Colour* (in alcohol) black, the posterior border of the tergites obscurely ferruginous; antennæ, legs, and labral border reddish yellow.

*Head* smooth, the sulcus deep below and above, obsolete in the middle; labral punctures 2+2. *Antennæ* shorter than the face. *Eyes* separated by a space that is equal to more than three diameters, composed of about six transverse rows of ocelli. The *first tergite* smooth, evenly rounded laterally, with an anterior marginal sulcus, not reaching so low as the second. The second somite flat beneath. The rest of the segments shining but punctulate and striolate; the transverse sulcus well marked at the sides and punctured, fading away dorsally, where its place is taken by a secondary sulcus which rises on each side just above and in front of the pore; the inferior portions of the segments longitudinally sulcate both behind and in front of the sulcus.

*Pore* just in front of the sulcus. *Scobina* extending to about the 34th segment; the posterior borders of the segments above the scobina sometimes very conspicuously bisinuate, sometimes scarcely visibly so. *Anal tergite* not surpassing the valves, the process rounded and nearly rectangular. *Valves* lightly compressed but not sulcate marginally. *Sternite* triangularly rounded.

*Legs* shortish, with a single seta beneath each segment.

♂. Copulatory feet as in fig. 10.

Number of segments about 40.

♀. Length about 45 mm., width 5 mm.

♂.     "     "     38 mm.,     "     4 mm.

*Locality.* St. Vincent (*H. H. Smith*).;

*RHINOCRICUS SABULOSUS*, sp. n. (Pl. XXXVIII. fig. 12.)

*Colour* (in alcohol) yellowish red, with three very distinct black longitudinal bands, one in the dorsal middle line and one on each side on a level with the pores; head infusate; first tergite and anal tergite also infusate; antennæ and legs entirely pale.

*Head, eyes, antennæ, and collum* constructed as in the other species of this group.

The rest of the *tergites* very finely punctulate; the posterior part a little higher than the anterior; the anterior part obliquely striate below, the posterior longitudinally. The true transverse sulcus incomplete dorsally on all the segments, extending only slightly above the pore, but the secondary sulcus, which rises below the level of the pore and is nothing but one of the oblique striæ above referred to, crosses the vertex of the dorsum except upon a few segments at the anterior and posterior end of the body. *Scobina* present, extending to about the 20th segment. *Pores* rather small, situated just in front of a loop of the transverse sulcus. *Sterna* striolate.

*Anal somite* small; tergite obtusely angled posteriorly, not surpassing the valves; *valves* with margins not compressed.

Copulatory foot of male as in fig. 12.

Number of segments 35 ♀, 37 ♂.

Length of ♀ 22 mm., ♂ 17 mm.

*Locality.* Mandeville, Jamaica, 1950 ft. alt. (*T. D. A. Cockerell*).

I have seen two examples of this species; both of them, how-

ever, appear to be slightly immature, inasmuch as the three posterior segments are apodous.

The colouring of this species furnishes a very well-marked characteristic of it. In having a median dorsal black band it approaches *R. grammostictus* and *R. serpentinus*; from both, however, it differs in size and in having the flavous spot on each side of the dorsal middle line much larger and the lateral black band very strongly marked. Moreover, a further difference from *serpentinus* is the smaller number of its segments, and from *grammostictus* the absence of a tail.

*RHINOCRICUS COCKERELLII*, sp. n.

*Colour*: posterior portion of each segment widely flavous behind the transverse sulcus, this band is, however, very faintly fuscous in the dorsal middle line; the anterior portion of the segments is black above, ferruginous or lurid as high as the pore; head with a median T-shaped fuscous fascia as in *R. sabulosus*; anal tergite entirely ferruginous; valves flavous; antennæ and legs flavous.

Allied to *R. sabulosus* in nearly all respects; the transverse sulcus is incomplete dorsally on all the segments, and the supernumerary sulcus is only complete in the anterior half of the body; the posterior portion elevated. *Anal tergite* posteriorly very obtusely angled, not surpassing the valves; *valves* not compressed; *sternite* rounded.

*Legs* moderately long.

Number of segments 45.

Length 34 mm., width 3.5 mm.

*Locality*. Mandeville, Jamaica, 1950 ft. alt. (*T. D. Cockerell*).

Differs from the preceding principally in colour and number of segments. Perhaps of the extra-Jamaican species it comes nearest to *R. anguinus* from St. Lucia; but it certainly differs in colouring and in having the anal tergite obtusely and not acutely angled.

*RHINOCRICUS TOWNSENDI*, sp. n.

*Colour* entirely black, except for a fine pale border on the segments.

*Collum* without marginal sulcus. *Segments* without trace of a transverse sulcus above, the entire area being perfectly plane and unornamented from the anterior to the posterior border. The sulcus visible inferiorly and extending as far as about halfway up

to the pores, which are very conspicuous. *Scobina* absent. Inferior-lateral portions of segments striate, as also are the sterna. *Anal segment* small, the tergite not surpassing the valves, the borders of which are scarcely compressed; *sternite* triangular.

Number of segments 39-40. Length up to about 26 mm.

*Locality.* Jamaica (*T. Townsend*). Described since preparation of Synopsis, p. 486.

#### THYROPROCTUS, gen. nov.

Like *Rhinocricus* in the laterally rounded form of the collum, presence of scobina, number of labral pores, structure of copulatory apparatus, &c., but differing in the peculiar construction of the anal segment; the posterior border of the tergum is transverse and without any caudal process; the valves, which have no thickened edge, lie, when closed, almost at right angles with the long axis of the body, and the sternite is very large, thickened, and transversely elongate.

THYROPROCTUS TOWNSENDI, sp. n. (Pl. XXXVII. figs. 6-6 c.)

*Colour* black.

*Head* striolate above, with scarcely a trace of a median sulcus. *Antennæ* of moderate length. *Collum* smooth above, with lateral marginal sulcus; the rest of the segments (*i. e.* from the second to those quite at the end of the body) furnished with an abnormal transverse groove, which rises low on the sides from the normal groove and crosses the dorsum in front of the normal groove, which is much fainter than the other. The *pores* high on the side, close to the normal transverse groove, with a short groove just behind them. The area behind the normal transverse sulcus elevated. *Scobina* present in the anterior half of the body, but weak. *Sterna* striate.

*Legs* with a single seta below each segment.

Number of segments about 40.

Length about 40 mm.

*Locality.* Jamaica (*T. Townsend*).

\**IULUS INDUS*, *Pal. Beauvois*.

*Iulus indus*, *Pal. Beauvois, Ins. d'Afr. et d'Amér.* p. 154, pl. 6. fig. 2.

*Locality.* St. Domingo.

Judging by the figure, I believe the species identified by Palisot de Beauvois as *Iulus indus* to be a *Spirostreptus*.

This species and the following are of doubtful generic position.

\**IULUS BEAUVOISII*, Gervais.

*Iulus indus*, Palisot de Beauvois, *Ins. d'Afrique et d'Amérique*, p. 154, pl. 6. fig. 2.

*Iulus Beauvoisii*, Gervais, *Ann. Sci. Nat.* (2) vii. p. 47; *id. Ins. Apt.* iv. p. 191.

*Colour* for the most part blackish chestnut; head, antennæ, and legs ferruginous.

*Head* smooth above, finely rugose below, with three or four obsolete punctulations above the labral excision. *Antennæ* of moderate length, the segments contracted at the base, the second the longest. The lateral portions of the collum obliquely truncate, marked with two oblique sulci, the second of which is interrupted inferiorly; the anterior angle more prominent than the posterior, which is obtuse.

The upper surface of the body smooth, only very finely rugulose; the exterior part of the segments transversely striate; the posterior part marked below with feeble longitudinal striæ. *Anal tergite* not spined, transversely impressed; *sternite* triangular.

Number of segments 60.

Length 70 mm., width 5 mm.

*Locality.* Martinique.

It is very difficult to know what to do with this species. Gervais proposed the name *Beauvoisii* as a substitute for *indus* of Beauvois; but it is almost certain to my mind that the specimen he described as *Beauvoisii* from Martinique is not co-specific with Beauvois's specimen of *indus* from San Domingo. Consequently unless it has been renamed since 1847, it is nameless. Moreover, Gervais asserts that it is referable to *Spirobolus*. But in spite of the fact that he appears in other cases to have been well acquainted with the differences between this genus and *Spirostreptus*, I venture to think he fell into error in this instance. His description, especially where he mentions the collum and labral pores, seems to apply to a *Spirostreptus* very nearly related to the form I have named *antillanus*.

In a list of the described *Iulidæ* of N. America—an area which is provisionally expanded to include Central America and the W. Indies—recently compiled by Mr. Bollman\*, the following species are said to be West-Indian:—*Spirostreptus confragosus*, *flavicornis*, Karsch, and *surinamensis*, Brandt; *Spirobolus acutus*, *crassicornis*, Humb. & Sauss., and *flavocinctus*, *fundipudens*,

\* Ann. New York Ac. Sci. iv. pp. 44-45 (1887).

*miniatus*, Karsch. Moreover, it seems probable that *Spirobolus caudatus* of Newport and *Iulus* (*Paraiulus*) *rasilis* of Karsch are intended to be included, the letter "N" with which they are marked being, I suppose, a misprint for "W," which was Bollman's symbol for "W. Indian." I presume that Mr. Bollman saw specimens of *Iulidæ* ticketed "W. Indies," which he referred to the above species. But since I am not prepared to accept, without further information, either the localities or the identification of the specimens, I have thought it superfluous to include in this report further references to these species or notes upon their characters and affinities.

## Suborder POLYDESMOIDEA.

### Family POLYDESMIDÆ.

The genera of the family here recognized may be distinguished as follows:—

- a. The third segment like the second segment of a *Glomeris*, with its lateral portion enlarged, very much larger than lateral portion of the second and of the segments that follow it; all the keels vertical . . . . . [Sauss. CYCLODESMUS, Humb. &
- b. The third segment not larger than the rest and resembling them in structure; the keels not vertical.
  - a<sup>1</sup>. Pores invisible; keels depressed, the head concealed beneath an expansion of the first segment. . . . . CRYPTODESMUS, Pet.
  - b<sup>1</sup>. Pores visible on their appropriate segments; the head not concealed.
    - a<sup>2</sup>. Pores dorsal, situated in the centre of a perfectly circular smooth plate; caudal process wide, squared . . . . PLATYRHACHUS, Koch.
    - b<sup>2</sup>. The pores lateral, not surrounded by a smooth circular area; caudal process triangular, posteriorly narrowed with truncate apex.
    - a<sup>3</sup>. Keels of the 2nd segment rising below the level of those of the 1st and 3rd segments . . . . . STRONGYLOSOMA \*, Br.

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\* Syn. *Paradesmus*, Sauss.



- ♂<sup>3</sup>. Keels of the 2nd segment on the  
 same level as those of the 1st and [nom. nov.†  
 3rd..... ODONTOPELTIS,

CYCLODESMUS PORCELLANUS, sp. n. (Pl. XXXIX. figs. 1, 1 a.)

♀. Colour entirely white, like porcelain.

Body smooth.

Head with deep frontal sulcus. First tergite with its anterior border lightly emarginate, elevated, its inferior (anterior) angles less than right angles, the superior angles obtusely rounded; the 2nd segment arched as in *C. aztecus*; the 3rd segment very large, the anterior border of the lateral portion widely convex, the posterior border deeply concave; the 4th segment laterally about half the width of the 3rd. The rest of the segments as in *C. aztecus*, but with the posterior border of the keels of those in the posterior half of the body with a deep and conspicuous notch.

Length 9 mm.

Locality. Jamaica.

This species may be at once distinguished from the Mexican *C. aztecus*, the only other form of the genus, by the notch on the posterior border of its keels. In *aztecus* this border is entire.

\*CRYPTODESMUS LAQUEATUS, *Karsch, Mitth. Münch. ent. Ver.* 1880, p. 142.

Locality. Cuba.

"Pallidus vel infuscatus, unicolor, dorso subconvexo, segmentis dense sed plane granulosis, segmento primo subglabro, antice rotundato, plano, radiis imperfectis impressis supra ornato, postice convexo, ruguloso, antennis fuscis, pedibus pallidis. Long. corp. 10-12 mm."

\*CRYPTODESMUS ORNAMENTATUS, *Karsch, loc. cit.* p. 142.

Locality. Cuba.

"Fuscus, dorso alte convexo, carinis lateralibus planis, segmentis supra granulis subacutis, in series quatuor longitudinales dispositis interstitiisque granulis minoribus sparsis armatis, alis postice et extus sublobatis, segmento primo margine antico lobato antice plano, dorso alte convexo, granulis crassis subacutis inordinatis vestito. Long. corp. ca. 6 mm."

These two descriptions speak for themselves. They are practically valueless for the identification of the species.

† For *Rhacophorus*, C. Koch (1847), preoccupied in 1827 for a frog.

CRYPTODESMUS VINCENTII, sp. n. (Pl. XXXIX. figs. 2-2 d.)

*Colour* black, the borders of the segments pale, from which short pale bands run inwards towards the middle of the plate. Pale beneath.

*Head* punctured, shortly hairy, but smooth and shiny below; with a roughened cap on the forehead.

*Antennæ* with fifth segment the longest and thickest. The upper surface of the *body* roughened apparently by the presence of thickly-set minute pores, each of which bears a hair. The border of the first tergite even, not lobate; eleven abbreviated grooves radiate from it towards the centre of the plate, which is elevated and tubercular. The rest of the tergites bear dorsally two parallel rows of crests, each consisting of three (the posterior smaller) rounded tubercles; a similar crest situated on the middle of the lateral surface; the rest of the tergites furnished with tubercles of various sizes. The keels depressed, completely covering the legs, contiguous, those of the 2nd directed forwards, those of the posterior 4 somites directed backwards, those of the 19th, however, not projecting beyond the level of the anal length; the anterior edge of the keel raised and entire, the anterior angle rounded; the lateral margin quadrilobate or trilobate at the anterior end of the body, the posterior angle squared or acute posteriorly, the posterior border straight or concave, notched in correspondence with the grooves that run on to the dorsal and ventral surface. *Pores* apparently absent. *Anal tergite* with two large tubercles on its upper surface, its posterior border trilobate, the median lobe large and rounded. *Sternite* bitubercular. *Sternal areas* as large as in *Polydesmus*, smooth and not spined. In the legs the trochanter is almost as long as the femur.

In the ♀ the sternum of the third somite is produced into an upstanding, trilobate ridge behind the generative aperture.

In the ♂ the keels are considerably less depressed than in the ♀; the sternum of the 8th somite is furnished in front with a pair of tubercles tipped with a brush of hairs, a somewhat similar tubercle being noticeable upon the coxa of the anterior legs of this somite. Copulatory feet crossed in a state of repose, swollen, and hairy at their proximal extremities; the distal sclerite elongate and slender, lightly curved, hollowed behind, terminating in two processes, one short and rounded, the other elongate, blade-like, and directed backwards.

Length of largest example (♂) 16 mm., width 4·5; length of ♀ described 13, width 3.

*Locality.* St. Vincent (*H. H. Smith*).

"Forest below 1500 ft., under rotting leaves; pretty common."

\**PLATYRHACHUS MACULATUS*, *Bollman, Pr. U. S. Nat. Mus.* 1888, p. 336.

*Locality.* Cuba.

Judging from the description of this species, its most remarkable character is its minute size. Mr. Bollman does not state that his two specimens are immature, yet the length of the ♀ is only 12·8 mm., and of the ♂ only 9 mm. The following species that I have described is small for the genus, which contains the giants of the family; but it is very much larger than this Cuban form of Bollman's.

*PLATYRHACHUS LUCIÆ*, sp. n. (Pl. XXXIX. figs. 3-3 d.)

*Colour* blackish brown above, the cylindrical part of the somites ferruginous, with a median black spot; legs, antennæ, and margins of keels ochraceous.

*Head* finely granular. *Antennæ* short. *First tergite* about as wide as the head, convex above, and covered with low close-set granules, a distinct row of small tubercles along the anterior border; the second tergite wider than the first and third, its keels like those of the third and fourth, depressed and directed forwards. The keels of the rest small and squared, situated above the middle of the side, and horizontal, although the upper surface follows the slope of the dorsum, the keels of the three posterior somites are directed backwards; the angles of the keels are nearly right angles, the external border lightly convex, entire or subgranular, the lateral portion of the keel marked off from the rest by a longitudinal groove. The whole of the upper surface of the posterior half of the somites somewhat coarsely sculptured, lowly granular, and divided up into areas very much as in *Polydesmus*, s. s., the centre of each area bearing a granule which is slightly more prominent than the rest. The *pores* situated in the posterior half of the keel just above the lateral edge. The lateral part of the segments sparsely and finely granular; the cylindrical very closely punctulate. The *anal tergite* posteriorly convex. *Sterna* smooth or obsoletely granular, but spined. *Legs* short, robust, and hairy.

♂. Flatter than the ♀. Copulatory feet small, curved, terminating in two slender processes, one of which is curled backwards.

Length: ♀, 49 mm., width 7.5; ♂, 45 mm., width 6.5.

*Locality.* Fond de Jacques, St. Lucia (*G. A. Ramage*).

*STRONGYLOSOMA COARCTATUM* (*Sauss.*).

*Polydesmus coarctatus*, *Sauss. Faun. Myr. Mex.* p. 39, fig. 18 (ex *Mém. Soc. Phys. Genève* for 1860).

? *Paradesmus coarctatus*, *Humb. & Sauss. Verh. z.-b. Ges. Wien*, xix. pp. 670, 671 (1869).

*Paradesmus vicarius*, *Karsch, Arch. Nat.* 1881, p. 38, pl. iii. fig. 8.

*Strongylosoma Poeyi*, *Bollman, Ent. Am.* iii. p. 81 (1887); *id. Proc. U.S. Nat. Mus.* 1888, p. 336 (as *Paradesmus*).

*Localities.* Union Island, Barbadoes (*G. Smith*), Dominica (*G. A. Ramage*), Jamaica (*T. Townsend*).

*STRONGYLOSOMA SEMIRUGOSUM*, *Pocock*, "Contributions to our Knowledge of the Myriopoda of Dominica," *Ann. Mag. Nat. Hist.* (6.), ii. p. 477, pl. xvi. fig. d.

*Locality.* Dominica (*G. A. Ramage*).

*ODONTOPELTIS SUBTERRANEUS* (*Sauss.*).

*Polydesmus subterraneus*, *Sauss. in Linn. Ent.* xiii. p. 323 (1869); *Faun. Myr. Mex.* p. 44, pl. i. figs. 6, 7.

*Locality.* Cuba (Grotto of Cotilla).

A specimen of this species in the British Museum collection agrees closely with de Saussure's figure and description.

The copulatory foot is somewhat complicated; it consists of two processes closely applied together; the upper one is a somewhat hammer-shaped piece, of which one end of the head is long and produced inwards, with the apex lightly curled; the other piece expands distally, then abruptly narrows to a long, flexible, coiled flagellum.

\**ODONTOPELTIS SALLEI* (*Sauss.*).

*Polydesmus Sallei*, *Sauss. Faun. Myr. Mex.* p. 42, pl. ii. fig. 8.

*Locality.* San Domingo, Haiti.

According to de Saussure this species approaches the genus *Strongylosoma* so far as the development of its keels is concerned. These organs are widely separated, rise a little above the middle of the side, are horizontal, with the anterior angle rounded, the posterior squared.

Length 34 mm.

\**ODONTOPELTIS COULONI* (*Humb. & Sauss.*), *Rev. Mag. Zool.* 1869, p. 151; *Miss. Sci. Mex., Myriap.* p. 43, pl. i. fig. 9.

*Locality.* Cuba.

According to de Saussure this species resembles *R. Sallei*, but is a little larger and flatter; the keels are better developed and situated higher; the upper surface of the metasomites is furnished with a few scattered granules, and the posterior border of each keel has one or two dentiform granules; there is a shallow transverse sulcus between the keels, for the rest the dorsum is smooth and shining.

Length 35–44 mm.

\**ODONTOPELTIS MAGNUS* (*Bollman*), *Proc. U. S. Nat. Mus.* 1888, pp. 336, 337.

This species was described from Cuba. It was based upon a mutilated female of which the first six segments and the head had disappeared. The fourteen segments that remained measured 22.5 mm. in length, so that the entire specimen must have been upwards of 30 mm. long.

Mr. Bollman declared this species to be related to *O. morantus* of Karsch from Jamaica. It appeared to differ, however, in the presence of an indistinct row of tubercles along the anterior and posterior margins of the segments, and a few on the lateral carinæ.

The upper surface is marked with a transverse sulcus. The keels are large and strongly marginate, the anterior angles rounded and the posterior much produced. The pores are large, subapical and marginal.

Colour brown, legs light chestnut.

\**ODONTOPELTIS MAURITII* (*Brandt*).

*Polydesmus mauritii*, *Brandt, Bull. Sci. St. Pétersbourg*, v. p. 311 (1839).

*Oxyurus mauritii*, *Peters, Monats. Ak. Wiss. Berlin*, 1864, p. 533.

*Locality.* Porto Rico.

The description given by Brandt is the only one that I have seen of this species. Peters merely refers it to its correct genus.

According to Brandt, the colour is blackish, with the posterior border of the segments pale; all the segments are very smooth above; there is, however, a granule at the base of the keels on some of the segments.

ODONTOPELTIS VINCENTII, sp. n. (Pl. XXXIX. figs. 4-4 d.)

*Colour* chocolate-brown, keels flavous, with a triangular flavous spot on the middle of the dorsal surface of the keel-bearing portion; antennæ ferruginous; legs and sterna flavous or ochraceous. Smooth and polished.

♀. Robust and parallel-sided. *Antennæ* moderately long and slender; 2nd to 6th segments subequal.

*First tergite* as wide as the second and the rest, its anterior border convex; the keel well-developed, depressed, its anterior angle convex, posterior rectangular and sharp. The keels of the 2nd and 3rd also well-developed, depressed, and contiguous; that of the 4th much smaller, with its posterior angle strongly produced and dentiform. In the rest of the somites the dorsal surface is not sulcate, the keels rise above the middle, but not at the summit of the side; they are horizontal but small, with convex anterior angle, acute and produced posterior angle; the lateral border thickened, especially round the pore, this thickened area defined in front by a conspicuous notch; lateral surface of somites smooth above, granular below. *Anal tergite* as in *Strongylosoma* or *Paradesmus*. *Sternite* triangular, with the two tubercles before the apex. The sterna wide, not spined. *Legs* of moderate length, the trochanter twice as long as the coxa, the tarsus hirsute and much shorter than the femur.

♂. Slenderer than ♀, but with larger keels. The sternum of the 6th somite excavated. The copulatory feet short, terminating in three subequal prongs, of which the external is stout at the base and very slender and curved distally; the internal much slenderer at the base but less abruptly narrowed; the third, situated above and between the others, is almost filiform.

In the legs the tibia is furnished beneath with a distally directed process, which underlies the proximal end of the tarsus.

Length of ♀ 27.5 mm., width 4 mm.; ♂ 26, width 3.8.

*Locality.* St. Vincent (*H. H. Smith*). "Common under ru sh."

This species shows considerable variation in colour: in some cases the median yellow spot on the back is entirely absent, and the yellow of the keels much less pronounced; in others the yellow patches are so much enlarged that the brown area is reduced to a single large spot on each side. Since, however, these coloured forms do not appear to differ in other respects, I regard all of them as belonging to the same species.

ODONTOPELTIS MORANTUS (*Karsch*), *Arch. f. Naturg.* 1881, p. 39. (Pl. XXXIX. figs. 5, 5 a.)

*Colour* brown above, with the keels and hinder border of the tergites flavous; antennæ and legs flavous.

*First tergite* smooth above, its anterior border evenly convex from angle to angle; posterior border trisinate, angles acute, dentiform. Second and third tergites smooth or nearly so above, the keels well developed, with convex anterior border, emarginate posterior border, and straight thickened lateral border, the posterior angle acute and produced. The fourth tergite obscurely sculptured above. The fifth and following tergites conspicuously sculptured above, marked with a median longitudinal groove, from which a transverse groove passes on each side, dividing the surface into areas nearly as in *Polydesmus* (s. s.); the lateral portions of the upper surface ornamented with (6) large low subcontiguous tubercles, the posterior of which are subacute, the one that is next to the keel projecting as a conical tooth beyond the posterior edge of the tergite. The *keels* rising just above the middle of the sides, horizontal but not wide, the anterior angle rounded, the posterior acute and spiniform, the lateral border armed in front with a small tooth; a distinct notch in front of the thickened porous area. *Pores* looking upwards and outwards. Lateral surface nearly smooth, with a sharp keel above the base of the legs in the anterior half of the body. *Caudal process* triangular; the apex truncate, with a conspicuous lateral tubercle in front of the apex. *Sternite* obtusely triangular, with a setiferous tubercle in the middle of its lateral border. *Sterna* wide, scarcely emarginate posteriorly.

*Legs* of normal length; the trochanter about half the length of the femur; the patella and tibia about as long as the tarsus, the three together a little longer than the femur.

♂. Keels a little higher than in female, giving a slightly flatter appearance. Legs a little shorter and more robust.

*Copulatory feet* short and robust, the apex expanded, compressed, and bent forwards and downwards; two processes arise from the upper (anterior) surface of the femoral segment, near its base; the external of these bends inwards, the internal outwards, the two crossing each other.

Length 20 mm.

*Locality.* Jamaica (*Brit. Mus. and Berlin Mus.*).

This species seems to differ from all the preceding in the

sculpturing of the dorsal surface, which calls to mind that of the genus *Polydesmus* (s. s.). Another noticeable feature is the presence of the large spiniform tooth on the posterior border of the keel at its base.

ODONTOPELTIS VERRUCOSUS, sp. n. (Pl. XXXIX. figs. 6-6 *d.*)

*Colour* : head and upper portion of cylindrical part of segments chocolate-brown, the rest of the body (*i. e.*, antennæ, legs, sterna, keels, and keel-bearing part of somites) yellow.

*Antennæ* elongate, the second to the fifth segments subequal in length and thickness, the sixth the longest.

*First tergite* about as wide as the second, thickly granular throughout, its anterior border evenly convex, the posterior straight from side to side although lightly sinuate, the lateral portion upturned and carinate, the posterior angle squared and sharp. In the *rest of the somites* the cylindrical part is smooth, the posterior and cariniferous part thickly granular, with a series of six larger granules along the posterior border, and obscurely impressed transversely in the middle. The *keels* well-developed, horizontal, rising at the summit of the sides, the anterior border convex, the posterior correspondingly concave; the posterior angle acute and dentiform, projecting far beyond the hinder border of the tergites, at least in the posterior half of the body; the posterior border bearing a conspicuous tubercle near the point of origin of the keel, the rest of the hinder border denticulate; the lateral border dentate and denticulate; the keels that bear pores furnished with a strong median notch. The *pores* lateral but looking slightly upwards, situated in a depression in front of the posterior angle; area below the keels granular; granular crests above the legs at the anterior end of the body. The *anal tergite* narrowed, but truncated apically, furnished apically with two piliferous tubercles and laterally with others. *Sternite* triangular, the two tubercles situated in front of the posterior margins. *Sterna* wide, smooth, and not spined. *Legs* elongate and closely hairy, the 1st, 2nd, 4th, and 5th segments about equal in length, also the 3rd equal to the 6th and as long as two of the others.

♂. Slenderer than female, with keels a little more elevated, the sternum of the 4th and 5th somites bearing two hairy tubercles.

*Copulatory feet* short, robust, contiguous but not crossing;



each consisting of two processes which are very unequal in size—the larger expanded distally, hollowed and curved outwards at the apex; the shorter, also curved, is directed upwards and forwards on the inner surface of the larger.

Length of ♀ 24 mm., width 3·5; ♂ 23, width 3.

*Locality.* Jamaica (*T. D. A. Cockerell and T. Townsend*).

Evidently allied to the preceding, but differing in very many points. Thus the upper surface is thickly granular, the sculpturing less clearly defined, the tooth at the base of the posterior border of the keel larger, &c.

ODONTOPELTIS FORMOSUS, sp. n. (Pl. XXXIX. fig. 7.)

Closely allied to *O. morantus*, Karsch.

♀. *Colour*: upper surface with a wide flavous median dorsal band, brown laterally, with the external portion of the keels also flavous; head and anal somite entirely brown; antennæ and legs flavous, the latter proximally slightly darker. *Body* robust and nearly flat, the keels being horizontal and rising near the summit of the sides. The *first tergite* with evenly convex anterior border, acutely-angled keels, and mesially emarginate posterior border. The *rest of the segments* smooth and polished, but sculptured almost as in *Polydesmus* (s. s.), being divided by a median longitudinal sulcus and by a transverse sulcus; the area behind the transverse sulcus divided into two transverse series of polygonal areas: from each of the two external areas of the posterior series springs a backwardly directed spiniform tooth; of these teeth the external is larger than the internal, and is situated at the point of origin of the keel, the internal of them is smaller and is not present on the 1st, 18th, and 19th segments. The anterior area of each segment furnished with two setiferous tubercles. *Keels* moderately large, the anterior border convex, posterior border deeply concave; external border dentate, and furnished with two spines in its anterior half, the posterior of these being formed by a deep notch, which marks off the thickened porous area; anterior angle of the keel rounded, the posterior acutely produced. *Pores* large, looking upwards and backwards.

Total length 17·5 mm.

*Locality.* Mandeville, Jamaica (*T. D. A. Cockerell*).

This species may be at once recognized from *O. morantus* by the denticulation of the lateral margin of the keels, its more pronounced sculpturing, and different arrangement of the colours.

ODONTOPELTIS MAMMATUS, sp. n. (Pl. XXXIX. figs. 8-8 b.)

Allied to both the preceding.

♂. *Colour* black, legs ferruginous. Slender, flat-backed. *Keels* large and horizontal, formed almost as in *O. formosus*, but with the posterior angle of the keels more produced and the whole sculpturing much less like that of a genuine *Polydesmus*; the upper surface of each segment adorned on each side with seven mammiform excrescences, three of these along the posterior row being more spiniform and directed backwards, especially the external, which has the form of a large tooth at the point of origin of the keel.

*Legs and antennæ* long.

*Copulatory feet* very short (as in figs. 8 a, 8 b).

Length 17 mm.

*Locality.* Mandeville, Jamaica (*T. D. A. Cockerell*).

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## II. MALACOPODA OR PROTOTRACHEATA.

Any one versed in the problems of geographical distribution and acquainted with the wide range, probable antiquity, and secluded life of the species that have hitherto been included under the genus *Peripatus*, would have been perfectly justified in concluding from analogy that the species from each of the different regions would possess certain characters in which they would resemble each other and differ from the species inhabiting the other regions.

That this is in reality the case is now an established fact; for the species from the Neotropical Region may be distinguished from those from Africa and Australia, and those from the latter two Regions from each other, by both external and internal characters; or, to put it differently, the species fall into three groups equivalent to, or indeed of considerably greater value than, the genera of other orders of animals.

Setting aside for the moment the less easily ascertained characters, which may be found detailed in Prof. Sedgwick's monograph, I propose to distinguish these genera by the following characters and names:—

- a. The legs furnished with four spinous pads; the generative aperture in the adult always situated between the legs of the penultimate

pair. Neotropical Region and possibly Su-

matra ..... *PERIPATUS*, Guilding.

Type, *juliformis*, Guilding.

b. The legs furnished with only three spinous pads; the generative aperture behind the penultimate pair of legs.

a<sup>1</sup>. Generative aperture between the legs of the last pair and well in advance of the anus.

Australia and New Zealand ..... *PERIPATOIDES*, nov.

Type, *novæ-zelandiæ* (Hutton).

b<sup>1</sup>. Generative aperture behind the last pair of fully developed legs and close to the anus

at the hinder end of the body. S. Africa... *PERIPATOPSIS*, nov.

Type, *capensis* (Grube).

In the above brief diagnosis of *Peripatus*, Guilding, I have advisedly inserted the words "in the adult" after the statement respecting the position of the generative aperture, because in some immature individuals of this genus the posterior pair of legs of the adult is not fully developed, and the orifice in question then appears to be between the legs of the last pair. This at least is the case in one specimen of *P. Imthurni*, with 30 pairs of legs and 29 mm. long, that was collected in Demerara by Mr. J. J. Quelch. That the young sometimes have an imperfect number of legs was first pointed out by Dr. Ernst. Prof. Sedgwick, however, contested this view on the ground that it did not apply to any of his specimens. The Venezuelan naturalist, nevertheless, was not altogether in error, although his generalization from his observations has not proved to be justifiable.

Although specimens of *Peripatus* are known from a great many of the W. Indian Islands, as a glance at the following list of names of localities and so-called species will show, our knowledge of the actual number of the species represented in the fauna of the Antillean subregion is deplorably imperfect. That the specimens are to be referred to several species is highly probable, but their limits and extent can only be ascertained by an examination of long series of well-preserved examples from the different islands. It is to be hoped that residents in the West Indies will strive to contribute towards this end by collecting specimens of this interesting genus, killing them by drowning and making notes of their colours before immersing them in alcohol for preservation.

The characters which have been most used for distinguishing the species are: (1) the number of legs, (2) the form of the skin-papillæ, (3) colour, and (4) the dentition of the jaws. The last is troublesome to determine, and is not on that account likely to be very much patronized, and unless its validity has been tested in a large number of cases it should be employed with very great caution\*. Colour unfortunately is very liable to destruction by the alcohol. So, too, does the form of the papillæ seem to be affected by this preservative. These papillæ are contractile processes of the skin: when distended they in nearly all cases are seen to consist of a conical or cylindrical basal portion tipped with a slender, subcylindrical, setiferous distal portion; when contracted they are rounded and dome-shaped, with a distinct circular depression on the summit; at intermediate stages the distal portion appears like a button-shaped cap upon the basal portion; moreover it appears that the shape of these organs may be different when they are viewed from the front and the side. All these facts point to the conclusion that the form of the papillæ cannot, at present at least, be greatly relied upon for distinguishing the species. As for the number of the legs, they differ according to sex, and vary within undetermined limits in the sexes.

These considerations will show how purely provisional must be regarded all our conclusions respecting the validity of the species enumerated below.

*PERIPATUS JULIFORMIS, Guilding.*

*P. juliformis*, *Guilding*, *Zool. Journ.* ii. p. 443, pl. 14 (1826); also in *Isis*, xxi. p. 158, pl. ii. (1828); *Sedgwick, Quart. Journ. Micr. Sci.* xxviii. p. 478; *Pocock, Nature*, vol. 46, p. 100.

*P. Edwardsii*, *Sedgwick, op. cit.* pp. 467–473 (? *Edwardsii*, *Blanchard*).

*Colour* (in alcohol): the dorsal surface varying from almost black to a greyish brown or fawn; viewed with a lens, distinctly mottled, the mottling being attributable to the circumstance that the papillæ are of a paler tint than the skin which supports them; there is a dark more or less clearly defined narrow median dorsal longitudinal band, this band being apparently mostly due to the discontinuity of the papillæ across the middle line of the back, which permits the darker colour of the skin to be

\* I refer here merely to the small series of teeth on the inner blade of the jaw.

seen without interruption; the ventral surface is pale, and varies from fawn- to flesh-coloured. One specimen, which seems to have so far suffered less than the others from the action of the spirit, has the dorsal surface nearly black and the ventral distinctly flesh-coloured; the antennæ are rather darker than the rest of the dorsal surface; the legs are externally the same colour as the dorsal surface, and internally pale like the ventral.

The principal *papillæ* vary in form according as they are lengthened or contracted; when contracted, as on the dorsal surface of the largest specimen from St. Vincent, they are circular at the base and rounded at the summit, without any visible distal portion; when lengthened, the basal portion becomes narrower and more cylindrical, and a distal portion, tipped with one, two, or very rarely three setæ, projects from its summit, the whole papilla then resembling in appearance a short candle-end in a cylindrical candle-stick; sometimes the distal portion is expanded at its apex.

Blades of the jaw seem to be like those of the Caraccas species described by Sedgwick; thus the outer has a single tooth at the base of the fang, while the inner has a single very similar tooth at the base of the fang; and this is followed by a series of seven subequal but much smaller teeth.

*Legs* vary in number from 29 to 34 pairs; there are two papillæ on the anterior aspect of the feet: the claws are lightly curved; those of the last pairs are smaller than those that precede them, and have two instead of four pads. Some of the posterior legs in the male are furnished with one or two white tubercles, the distribution of which in the posterior six pairs in one example is as follows:—24th 2-0; 25th 1-1; 26th 2-1; 27th 1-1; 28th 0-0; 29th 0-0.

Female larger than male, with 33 or 34 pairs of legs; male with 29 or 30 pairs.

Measurements of largest specimens: female, length 44 mm., width 6 mm.; male, length 26 mm., width 4.5 mm.

*Locality.* St. Vincent (*H. H. Smith*).

Of this species I have seen six specimens: four females, two having 34 and two 33 pairs of legs, and two males, one with 29, the other with 30 pairs of legs.

With the first set of this species sent by Mr. Smith is the following note: "Rare in rotten wood and decaying leaves."

Another specimen, subsequently obtained, was found in the forest at an altitude of 1000 feet under rotten leaves.

There are, I think, no reasonable grounds for doubting that these specimens are referable to the species named *juliformis* by Guilding—a species based upon an example from the same locality, which was said to have 33 pairs of legs. So, too, does it seem that they are almost certainly co-specific with the specimens from Caraccas described as *Edwardsii* by Sedgwick. For the two sets of specimens agree in colouring, number of legs, armature of jaws, and apparently in the shape of the papillæ. As for *Edwardsii* of Blanchard, I suspect that it has been redescribed as *Imthurni* by Sclater; for it is more probable that a specimen from French Guiana should be co-specific with others from British Guiana rather than with a third set from Caraccas. Moreover, bearing in mind the fact that males seem to be scarcer than females, it seems more likely that the type of *Edwardsii* was of the latter sex than of the former. If this prove to be the case, this type will agree with the female of *Imthurni*, and differ from that of *juliformis* in the number of its legs.

*PERIPATUS TRINIDADENSIS*, *Sedgwick*.

*P. Edwardsii*, *Kennel*, *Arb. Zool. Inst. Würz.* vi. p. 282, 1884 (? *P. Edwardsii*, *Blanchard*, *Ann. Sci. Nat.* (3) viii. p. 140, 1847 = *P. juliformis*, *Aud. & Edw. Ann. Sci. Nat.* (1) xxx. p. 413).

*P. trinidadensis*, *Sedgwick*, *Quart. Journ. Micr. Sci.* xxviii. p. 377.

*Colour* of dorsal surface chocolate-brown, of ventral surface light brown.

*Papillæ* with basal part conical, as in the specimens from Demerara named *Imthurni*. The inner blade of the jaws furnished with a larger number (10–11) of minor teeth.

Number of pairs of legs 28–31.

*Locality.* Trinidad; Dominica (*G. A. Ramage*).

Mr. Ramage obtained at Laudat in Dominica three female examples of a *Peripatus*, each having 30 pairs of legs, which seem to be specifically identical with Kennel's specimens from Trinidad. Kennel identified his examples as *Edwardsii* of Blanchard, and very possibly quite correctly. Prof. Sedgwick, however, acting upon the supposition that his specimens from Caraccas were *Edwardsii* of Blanchard, and recognizing their distinctness from Kennel's examples, proposed the name *trinidadensis* for the latter. This name can provisionally stand until the veritable *Edwardsii* is rediscovered.

I have not seen any specimens of *Peripatus* from Trinidad with which to compare these Dominican individuals. Two of them, however, were sent by Prof. Bell to Prof. Sedgwick, who stated (in MS.) that they were more nearly related to *trinidadensis* than to any other Neotropical species. Certainly the third, and largest, specimen, which was, I believe, not seen by Prof. Sedgwick, possesses at least as many as ten minor teeth on the inner blade of the jaw of the left side; so in this character, as well as in the number of its legs and shape of its papillæ, it agrees with Prof. Sedgwick's *trinidadensis*. There can be very little doubt, I think, as to the distinctness of this form from *juliformis*; but I am strongly disposed to think (1) that it will prove to be the same as the Demeraran species *Imthurni* †, Sc Slater (= *demeraranus*, Sedgw.), and (2) that both names will have to be added to the synonyms of *Edwardsii* of Blanchard. *Imthurni* and *trinidadensis* apparently agree in the conical‡ form of their papillæ as well as in the number of legs in the female. The males, however, are unknown.

\**PERIPATUS TORQUATUS*, Kennel, *Arb. Zool. Inst. Würz.* vi. p. 282; Sedgwick, *Quart. Journ. Micr. Sci.* xxviii. p. 477.

"Colour of dorsal surface red-brown, the middle of the back being somewhat darker, and paling off towards the sides. Head and tentacles black, and marked off from the body on the dorsal side by a bright yellow band, which often shows a small interruption in the middle line. Ventral surface has a dark flesh-colour."

Number of pairs of legs 41-42.

Length of female 150 mm., width 8 mm.; length of male 100 mm.

*Locality.* Trinidad.

This appears to be a well-marked species on account of its large number of legs and the presence of the yellow band behind the head.

† Described briefly by Mr. W. L. Sc Slater on p. 133 of the P. Z. S. for 1887, and subsequently named in the 'Quart. Journ. Micr. Sci.' xxviii. p. 344; on p. 476 of the latter volume Prof. Sedgwick proposed the name *demeraranus* as a substitute for *Imthurni*.

‡ On pp. 475-476 of the monograph Prof. Sedgwick points out that in *demeraranus* the principal papillæ have conical bases, and thus differ from the same structures in his *Edwardsii*, which are cylindrical but in his brief diagnosis of *demeraranus* on p. 476, and again on p. 488, he says "*cylindrical primary papillæ*."

PERIPATUS JAMAICENSIS, *Grabham & Cockerell, Nature*, vol. 46, p. 514 (1892).

"Colour dark purplish brown, with no dark median dorsal line, the ends of the antennæ sometimes pure white.

"Number of pairs of legs 29 and 36; the claws are only slightly curved, and not hooked as in Prof. Sedgwick's *P. Edwardsii*.

"*Papillæ* are of two kinds."

I have seen no fuller description of this species than that cited above.

Presumably the three Jamaican specimens in the British Museum, briefly described by Prof. Sedgwick on p. 482 of his monograph, belong to the same species. These specimens are in a fairly good state of preservation; they are of a uniform dark brown above, paler beneath. Two of them, probably females, have 31 pairs of legs, and the papillæ are, as usual, of two kinds, large and small, the smaller lying between the larger: the latter, when seen from above, are circular in outline; when seen from the side, conical, the summit either is circularly depressed or supports a subcylindrical setiferous distal portion. The claws are normally curved as in *P. juliformis* and *P. trinidadensis*.

The third specimen has 37 pairs of legs, each leg of the 34th and 35th pairs being furnished with two enlarged tubercles, such as characterize the male of *P. juliformis*. These tubercles are not very obvious, and appear to have been overlooked by Prof. Sedgwick. The papillæ on the dorsal surface seem to be all of one kind; they are small, conical in outline, close-set, and tipped with a seta. Thus in three points this specimen seems to differ from the other two—namely, in the greater number of its legs, the form of the papillæ, and the presence of two enlarged tubercles on two of the posterior pairs of legs. The last is probably of a sexual nature; it seems possible, too, that the first is also, in which case this species presents a curious variation from *P. juliformis*, in which the males have fewer legs than the female.

Another specimen in the British Museum appears to be referable to this same species, although it differs considerably in colour from Gosse's examples. This is the Dominican individual obtained by Mr. G. F. Angas. This specimen has already been briefly reported upon by Prof. Bell, Mr. Sclater, and Prof. Sedgwick; but these authors seem to have omitted to state that the distal third of each antenna is pale yellow, and contrasts



strongly with the rest of the appendage, which is deep black ; the back of the head is also pale, apparently somewhat as in *P. torquatus* ; the sides of the body are purplish brown, the middle portion of the upper surface is pale reddish brown, obscurely mottled, and marked with a deep-coloured median dorsal line. The external surface of the legs is pale coloured, and not of the same tint as the upper surface of the body.

There are 29 pairs of legs, as in one of the specimens mentioned by Dr. Grabham and Mr. Cockerell.

The large and small papillæ are arranged as in the female Jamaican specimens ; but the former are distinctly antero-posteriorly compressed, and appear in outline to be conical or cylindrical, the variation in form depending upon the aspect from which they are examined. Each supports, as usual, a shorter or longer button-shaped or subcylindrical setiferous distal portion.

In addition to the specimens from the above-mentioned islands, unidentified examples of *Peripatus* have been reported from Cuba, Porto Rico, St. Thomas, and St. Croix.

#### SUPPLEMENTARY NOTE.

Since the above was written, three additions have been made to the literature of West-Indian Peripatidæ. The first is a paper by Dr. Grabham, published in vol. i. of the 'Journal of the Institute of Jamaica,' p. 217, in which further information respecting *P. jamaicensis* is to be found.

From this paper it appears that in the females of *P. jamaicensis* the legs vary in number from 29 to 43. The colour, moreover, also varies considerably. Some examples are entirely black above, including the antennæ, and dark brown on the underside ; others are pink or flesh-coloured, with a row of rusty-red markings along the back, and the extremities of the antennæ are pure white. It is interesting to note that the embryos taken from parents of either type of coloration have white-tipped antennæ and flesh-coloured mottled skins like those of the second type. Subsequently Mr. Cockerell (Zool. Anz. xvi. p. 341) has proposed names for these two forms of *P. jamaicensis*. But since they appear to be neither varieties nor species, this author terms them mutations. Thus we have "mutation" *Gosseï*," with reddish skin and white-tipped antennæ, and "mutation" *Swainsonæ*, with black skin and uniformly coloured antennæ.

The third paper is an account of the anatomy of a *Peripatus* from Dominica, by E. C. Pollard, published in vol. xxxv. pt. 2, of the Quart. Journ. Micr. Sci. 1893. This *Peripatus* is incidentally named *P. dominicæ* on p. 290. It is said to differ from *P. Edwardsii* of Sedgwick in that (1) it has from 25 to 30 pairs of legs instead of 29 to 34, and in that (2) there are on the legs no white papillæ, such as are found in the males of *P. Edwardsii*. Moreover, it differs from *P. trinidadensis* in the number of its appendages, the latter having 28–31 pairs, and in the number of teeth on the inner blade of the jaw, *trinidadensis* having a much larger number. And, lastly, in *dominicæ* the primary papillæ are cylindrical, while in *trinidadensis* they are conical.

The obvious question that arises in connection with these specimens of *P. dominicæ* is:—Are they or are they not co-specific with the examples mentioned above which were obtained in the same island and by the same collector? The latter examples certainly seem to differ from those described by E. C. Pollard in their dentition and in the form of the papillæ. But I confess that I am still sceptical concerning the value that is to be attached to these characters. As for the number of legs, since these appendages vary from 26 to 30 pairs in the females examined by E. C. Pollard, it is hard to find rational grounds for considering that female examples from the same island, in which the legs vary in number from 28 to 31 pairs, belong to a different species.

Lastly, concerning the Dominican individual obtained by Mr. Angus. In the number of its legs, as well as in colour, it agrees with the majority of the examples examined by E. C. Pollard, and the papillæ are cylindrical, when examined from the side; so there can be little doubt that it is referable to *P. dominicæ* of Pollard. But since Dr. Grabham and Mr. Cockerell have shown that in the Jamaican *Peripatus* a similar colouring may or may not occur, we are still in doubt as to whether *dominicæ* is specifically different from *jamaicensis*, and as to whether it may not be merely a "mutation" of *trinidadensis*. I am inclined to the latter opinion.\*

\* See Additional Note on p. 542.

III. SUPPLEMENT *on the PEDIPALPI of the West Indies.*

On page 404 of the present volume I fell into the error of regarding the West-Indian specimens of the genus *Tarantula* (= *Phrynus* of authors) as belonging to but one species. During the past month, however, a more detailed study of the rich material of this group contained in the collection of the British Museum has shown me that this is very far from being the case.

As a result of this study, I venture to propose the following new species of the genus. At the same time I deeply regret that I have, with one exception, failed in my attempt to identify any of the species established by previous authors. It is therefore highly probable that I have unknowingly renamed some or all of them.

In the paper above referred to I have given my reasons for considering that the genus in question should bear the name *Tarantula*. For the type of the genus *Tarantula* of Fabr. is a species named *reniformis* by Linnæus; Linnæus having based his species upon the figure, published in Brown's 'History of Jamaica,' of one of the members of this group which was reported from the Island of Antigua. Now this figure incontestably represents an animal congeneric with all the species described below, and with only remote affinities with the S.-American Pedipalp to which Mons. Simon proposed to restrict the term *Tarantula* \*.

The following synoptical table will, it is hoped, help in the rapid identification of the species here described. It must not be supposed, however, that the species enumerated necessarily differ solely in the characters mentioned.

*Synopsis of the West-Indian Species of Tarantula.*

- a. Tibia of the chela armed above with 9 spines, of which the 3rd from the proximal end and the 4th from the distal end are the longest, there being *two* spines between these long ones ..... *viridiceps*.
- b. Tibia of the chela armed with 8 spines, of which the 3rd from the proximal and 4th from the distal end are the longest, with only *one* spine between these long ones.
- a<sup>1</sup>. Tibia of chelæ slender, the longest spine longer than the width of the segment †; lateral eye-groups mostly closer together, the distance between them

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\* This Pedipalp is consequently without a name. I therefore propose that it be called *Heterophrynus*, with *chiracanthus* of Gervais as the type.

† The width in this and all cases is taken from the upper inner edge to the under outer edge.

only a trifle greater than half the median length of the carapace, the anterior margin of which is more coarsely dentate laterally than mesially. Median ocular tubercle close to the anterior edge. Mandibles with an enlarged terminal tubercle.

- a*<sup>2</sup>. The six spines on the tarsus of the chela well developed; frontal process almost concealed.
- a*<sup>3</sup>. Legs exceedingly long, femur of the 1st more than twice, and tibia of 2nd equal to twice, the width of the carapace; 2nd tibial of 4th leg as long as the distance between the eyes. . . *longipes*.
- b*<sup>3</sup>. Legs shorter, femur of first and *à fortiori* tibia of 2nd less than twice the width of the carapace; 2nd tibial of 4th leg shorter than distance between the eyes . . . . . *spinimana*.
- b*<sup>2</sup>. The 1st and 3rd spines on the lower edge of the tarsus of the chela nearly obsolete; apex of the frontal process projecting forwards between the mandibles. . . . . *tessellata*.
- b*<sup>1</sup>. Tibia of chelæ stouter, spines shorter, none of them being so long as the segment is thick; the 1st and 3rd inferior spines on the tarsus of the chela nearly obsolete.
- a*<sup>4</sup>. Distance between the lateral eyes about half the median length of the carapace or less; the lateral teeth of its anterior border enlarged . . . (Blanch.). *Pallasii*
- b*<sup>4</sup>. Distance between the eyes noticeably greater than half the median length of the carapace.
- a*<sup>5</sup>. Distance between the median ocular tubercle and the anterior edge equal to about twice a diameter; the 1st spine on the upperside of the tarsus of the chela nearly obsolete; frontal process concealed.
- a*<sup>6</sup>. Eyes less widely separated; frontal border narrower and more coarsely dentate; with 8 superior spines on the tibia . . . . . *Keyserlingii*.
- b*<sup>6</sup>. Eyes more widely separated; frontal border wider and more finely dentate, with 7 superior spines on the tibia . . . . . *latifrons*.
- b*<sup>5</sup>. Distance between the median tubercle and the anterior border less than a diameter; 1st superior tarsal spine of chela longer; frontal process not concealed . . . . . *barbadensis*.

Family TARANTULIDÆ, *Karsch.*Subfam. TARANTULINÆ, *Simon.*Genus TARANTULA\*, *Fabr.*

*Tarantula*, *Fabricius, Ent. Syst.* vol. ii. p. 432, 1793, for *Phalangium reniforme* of *Linnaeus*.

*Phrynus*, *Lamarck, Syst. An.* p. 175 (1801); *Latreille, Hist. Nat. Crust. Ins.* iii. p. 48 (1802).

*Admetus*, *C. Koch, Uebersicht des Arachnidensystems*, pt. v. p. 81.

TARANTULA BARBADENSIS, sp. n. (Pl. XL. fig. 1.)

*Colour*: carapace and chelæ chestnut-red; the former with postero-lateral border flavous; abdomen ochraceous, with scarcely a trace of a pattern; legs fusco-ochraceous, paler than the chelæ, with very faintly defined flavous spots on the femora.

*Carapace* not coarsely granular, its frontal border widely emarginate, evenly denticulate, and not overlapping the base of the vertical median triangular process, which is easily visible throughout its length from above and has its apex not turned forwards; median ocular tubercle transverse, separated from the front border by a space which is less than its longitudinal diameter; distance between the lateral eyes equal to about two-thirds the median length of the carapace and equal to the length of the upperside of the femur of the chela; the lateral eyes a

\* Readers of this paper, who are unfamiliar with the problems of zoological nomenclature, must be warned that in a systematic zoological sense *Tarantula* is not a spider.

In the vulgar tongue the term *Tarantula* is indiscriminately applied to any large formidable-looking animal of the spider kind. The original *Tarantula* is of course one of the Italian hunting-spiders, or Lycosidæ. But our friends in the United States have transferred the name to one of their so-called Mygalidæ. I have even heard a *Galeodes* thus nicknamed, and I am told that the *Tarantula* of the Queensland settlers is the spider named *Holconia immanis*, one of the Sparassidæ. But in a zoological sense the *Tarantula* is not a spider at all, but one of the so-called Pedipalps.

The term appears to have been first used in zoological nomenclature to designate a definite genus by Fabricius in 1793; and this author was perfectly within his rights in applying the term to those animals which were subsequently called *Phrynus*. Dr. Thorell, it appears, would like still to preserve the name *Phrynus* instead of *Tarantula*, and I confess that he has my full sympathy in so wishing. But I can find no logical grounds to justify the change; and however much one may regret Fabricius's choice of the name, no one, it appears to me, has the right to revoke his decision.

little nearer to the lateral than to the anterior border, the latter distance less than half the distance between the eyes.

*Mandibles* scarcely granular above, and without an enlarged terminal tubercle.

*Chelæ* robust. *Trochanter* armed with 5 spines, 3 of which are inferior. *Femur* coarsely granular above, finely below, armed above with 5 spines, the first of which is double and much shorter than the second, which is shorter than the third, the fourth of median size, the fifth minute; armed below with 5 spines and about 2 spinules; the first spine a little longer than the second, third and fourth about equal and much shorter than the second, fifth not much larger than a spinule; the longest of these spines less than the height of the femur. *Tibia* robust, much wider than its longest spine; 8 spines above, the first, seventh, and eighth minute; the second, fourth, and sixth progressively decreasing in length towards the distal end of the segment, all of them shorter than the third and fifth, which are about equal; the lower edge armed with two long spines and three short ones; third spine on the tarsus longish, the first small; the first and third on the lower side minute.

*Legs*: femur of 1st longer than the width of the carapace by about one-third of its length, that of the 2nd a trifle greater than the width of the carapace and a trifle shorter than the femur of the 3rd, that of the 4th the shortest; tibia of 2nd equal to its femur, that of the 3rd a trifle longer, that of the 4th noticeably longer than its femur; the second and third tibials about two-thirds the length of the first, but a little shorter than the protarsal; the second tibial about half the length of the third and about one-third of the distance between the eyes.

*Measurements in millimetres*:—Total length 19; width of carapace 11·2, median length 7, distance between eyes 4·5. *Chela*: length of femur (upper side) 4·5, height 2·6, length of longest spine 2; tibia, length 7·2, width 3, length of longest spine 2·5; length of tarsus 3·5, of digit 4. *Legs*: femur of 1st 16·2, of 2nd 11, of 3rd 12, of 4th 10; tibia of 2nd 11, 3rd 12·5, 4th 11.

*Locality*. Barbadoes (*Col. Feilden*). Three adult examples, 2 ♂, 1 ♀.

The sexes of this species show no marked secondary sexual characters.

TARANTULA TESSELLATA, sp. n. (Pl. XL. fig. 2.)

*T. reniformis* (Linn.), Pocock, *Journ. Linn. Soc., Zool.* vol. xxiv. p. 404.

The description already published in the present volume was taken from a large example of a *Tarantula* obtained in the Island of St. Vincent, W. Indies, by Mr. H. H. Smith.

I now offer the following supplement to that description:—

Granulation of trunk coarse.

*Carapace* flattish, its frontal portion gently sloped downwards and forwards. The distance between the eyes considerably more than half the median length of the carapace and a little more than twice the distance between a lateral eye-cluster and the front or side edge of the carapace; median tubercle a little wider than long, its long diameter about equal to the distance that separates it from the anterior edge; this edge distinctly concave, finely dentate mesially, very coarsely dentate laterally, the lateral teeth directed upwards, the frontal process scarcely overlapped, its apex turned directly forwards and projecting as a distinct spike between the base of the mandibles.

*Mandibles* granular above, with two terminal tubercles enlarged, but the external the largest.

*Chelæ* coarsely granular above and below. *Femur* longer by about one-third of its length than the distance between the eyes; armed almost as in *T. barbadensis*, but with the spines longer and the first rising from the base of the second, which thus appears double; the second spine directed more upwards than the third, the first inferior spine as long as the height of the femur. *Tibia* rather narrow, much narrower than its longest spine; the spine armature above and below the same as in *T. barbadensis*, as also is it of the tarsus.

*Legs* long; femur of the 1st greater by nearly half its length than the width of the carapace, that of the 2nd exceeding the width of the carapace by about one-quarter of its length, equal to the femur of the 3rd and considerably excelling that of the 4th; tibia of 2nd equal to its femur, that of the 3rd greater by half the patella, that of the 4th greater by the whole of the patella; the second and third tibials of the 4th two-thirds the length of the first and longer than the protarsus, the second tibial distinctly longer than half the length of the third and equal to about half the distance between the eyes.

*Measurements in millimetres* :—Total length 28; carapace,

median length 10·5, width 17, distance between eyes 6. *Chela*: femur, length above 9·5, height 3·5, length of longest spine 3·5; tibia, length 13·5, width 4·2, length of longest spine 5; length of tarsus 6, of digit 5·8. *Legs*: femur of 1st 28·5, of 2nd 21, of 3rd 21, of 4th 17·5; tibia of 2nd 21, of 3rd 23·5, of 4th 20·5.

*Locality*. St. Vincent (*H. H. Smith*), many examples; Grenada (*H. H. Smith*), one young specimen; Santa Lucia (*G. A. Ramage*), three adult specimens.

Most of the examples from St. Vincent were found under the bark of a stump, in August, at an altitude of 150 ft.; two more, however, both young, were discovered in March under a stone at an altitude of 1000 ft., while a single young example from Grenada was obtained under a stone at the sea-level.

The series from St. Vincent shows some interesting structural variations. The above description is taken from the largest male that was least fractured. Another specimen, however, also a male, which was considerably damaged about the limbs, is a good deal larger, measuring 34 mm. in length, with the carapace 19 mm. wide. In other respects, however, so far as can be told, this example does not differ from the type; nor indeed do three other males, which have the carapace respectively 16, 15, and 13·5 mm. in width, except that they show that the second tibial of the 4th leg may be only about half the length of the third and the two together not longer than the protarsus, while two young males with the carapace 9·5 and 9 mm. wide have the said protarsus slightly longer than the said tibials, the chela shorter, and the distance between the eyes slightly less.

An adult female, with egg-sac, from St. Vincent, measuring 24 mm. long, with the carapace 14 mm. wide, has the chelæ and legs shorter than in the adult males, the femur of the chela being greater than the distance between the eyes by about one quarter of its length. The segments of the legs give the following measurements:—femur of 1st 21, of 2nd 15, of 3rd 15·8, of 4th 13; tibia of 2nd and 4th 14·5, of 3rd 16. These show that the femur of the 4th is less than the width of the carapace, instead of greater, as in the males.

Three adult examples from Santa Lucia, which appear to be specifically identical with the specimens from St. Vincent, are of interest, inasmuch as the female, which measures 26 mm., with the carapace almost 16 in width, has the chelæ and legs of the same length as in the males from St. Vincent, whereas the



largest male, which measures about 29 mm., with the carapace almost 18 wide, has the femora of the 1st leg very short, only as long, in fact, as the tibia of the 2nd.

*TARANTULA PALLASII* (Blanch.)\*. (Pl. XL. figs. 3, 3 a.)

*Phrynus Pallasii*, Blanch. *Organisation du Règne An.*, Arachnides, pt. xv. p. 170, pl. 10, &c.

*Colour.* Carapace and chelæ chestnut-brown; legs and abdomen paler, the latter paler than the legs and without distinct pattern; spots on femora and carapace very indistinct.

Granulation of the upper surface of the trunk rather coarse.

*Carapace* with its frontal region gradually and gently sloped downwards, nowhere vertical; distance between the lateral eyes about half the median length of the carapace, the tubercles equidistant from the anterior and from the lateral edge, which distance is almost half the distance between the eyes. The median tubercle scarcely wider than long, distance between it and the anterior border a little greater than its longitudinal diameter; the frontal border distinctly emarginate, coarsely dentate at the sides; the teeth very slightly upcurled.

*Mandibles* almost smooth above; external apical tubercle large.

*Chelæ* coarsely granular; *tibia* broad; the *femur* above about one-third greater than the distance between the eyes; spines short, the longest on the femur less than the height of the segment, and a trifle more than half the distance between the lateral eyes; the longest on the tibia (*i. e.* the third, which is much longer than the second) less than the width of the segment and about equal to three quarters of the distance between the eyes. The *spine-armature* like that of *barbadensis*, except that the 2nd spine on the upper edge of the tibia is shorter as compared with the 3rd, and there is a minute spinule at the base of the 6th. *Tarsus* smooth externally, a little longer than the distance between the eyes, armed below with one median long spine, the other two being represented merely by small spinules.

*Legs*: femur of 1st longer than the width of the carapace by about one-third of its length; femur of the 2nd noticeably greater than the width of the carapace, about as long as that of

\* I had described this species as new before I had an opportunity of examining Blanchard's paper. I there discovered that his specimen came from Martinique, whence the British Museum also has received examples.

the 3rd, and distinctly longer than that of the 4th; tibia of 2nd equal to the femur, that of the 3rd a little greater than its femur or just equal to it, that of the 4th greater than the femur; the second and third tibial segments a little less than two-thirds the length of the first and a little shorter than the protarsus; the second tibial more than half the length of the third, and equal to half the distance between the lateral eyes; the protarsi less than half the length of the tibiæ.

*Measurements in millimetres.*—Total length 19; carapace, median length 7·8, width 12, distance between eyes 4. *Chela* femur, length 6, height 3, length of longest spine 2; tibia, length 8·5, thickness 3, length of longest spine 2·6; length of tarsus 4·2, of digit 4. *Legs*: femur of 1st 19, of 2nd 14, of 3rd 14·2, of 4th 11·5; tibia of 2nd 14, of 3rd 15, of 4th 13·5.

*Locality.* Montserrat and Martinique.

The British Museum has upwards of a dozen examples which I refer to this species. Unfortunately all the large ones have no locality, and are structurally imperfect in one respect or another. This has compelled me to select a small example for description; but a study of the other specimens shows that the variation in characters is only slight. The colour approaches black, especially upon the carapace and chelæ; and the granulation is coarser. The largest example measures 25 mm. long, the carapace being 15 mm. in width and 10 in median length, the distance between the eyes being 5. Moreover the chela is longer, its femur being equal to nearly twice the distance between the eyes. In other respects, however, this specimen (probably male) agrees closely with the type, which is certainly male. Other examples, some of which are certainly female, have the legs shorter, the femur of the 2nd equalling the width of the carapace, the tibia of the 2nd and 3rd being also about equal.

This species seems nearly allied to *T. Goëssii*; but, according to Dr. Thorell, in the latter species the distance between the eyes is almost three times as great as the distance between either lateral cluster of eyes and the edge of the carapace. *T. Goëssii*, moreover, appears to be considerably larger, since it attains a length of 37 mm.

TARANTULA SPINIMANA, sp. n. (Pl. XL. figs. 4, 4a.)]

*Colour* (dry specimen). Carapace and chelæ fusco-castaneous; legs paler, with two ill-defined flavous spots on the femora;

terga fusco-ochraceous, fuscous for the most part in front, ferruginous behind.

*Carapace* rather finely granular; distance between the lateral eyes a little more than half the median length of the carapace; each tubercle about equidistant from the anterior and the lateral border, this distance being a little less than half the distance between the eyes; the frontal area nearly vertical at the sides, in the middle sloped at an angle of from 35 to 40 degrees, the median eyes thus looking forwards and upwards, the tubercle of these eyes normally high and separated from the anterior border by a space which is a little less than its longitudinal diameter; this border lightly emarginate, the teeth much stronger laterally, slightly upturned, the apex of the inferior median spine turned forwards and just visible when the carapace is viewed from above.

*Terga* sparsely granular.

*Mandibles* with a few granules above and a large external tubercle.

*Chelæ* moderately long and robust, the distance between the lateral eyes about two-thirds of the length of the femur and almost as long as the tarsus; the latter smooth externally, the femur and tibia coarsely, but not closely, granular: spines moderately long, the longest on the tibia greater than the width of the segment, but less than the distance between the lateral eyes; the longest on the femur equal to the height of the segment, but much less than the distance between the eyes.

*Legs* moderate: femur of the 1st a little shorter than twice the width of the carapace, that of the 2nd longer by about a quarter of its length than the width of the carapace; femur of the 3rd a little longer than that of the 2nd, which equals the femur and patella of the 4th; tibia of the 2nd about equal to the femur and more than twice the protarsus; tibia of the 3rd a little longer than the femur and more than twice the protarsus; the tibia of the 4th noticeably longer than the femur, the second and third segment, taken together, a little more than half the length of the first and almost equal to the protarsal, the second tibial nearly two-thirds the length of the third and a little more than half the distance between the eyes.

*Measurements in millimetres.*—Total length 21; median length of carapace 9, width of carapace 14, distance between lateral

eyes 4·5. *Chela*: height of femur 3, length 7·5, length of its longest spine 3; width of tibia 3·5, length 10·5, length of longest spine 4; length of tarsus 5. *Legs*: femur of 1st 26, of 2nd 18, of 3rd 19, of 4th 16; tibia of 2nd 18, of 3rd 20, of 4th 19.

*Locality*. Haiti (one example).

Easily recognizable from *T. Pallasii* in being smoother, having the carapace more abruptly sloped in front, the median tubercle nearer the edge, the median spine scarcely overlapped, the spines on the palpi much longer; the legs longer—*e. g.* the femur of the 2nd considerably exceeds the width of the carapace.

TARANTULA LONGIPES, sp. n. (Pl. XL. fig. 5.)

*Colour* (dry specimen). Carapace and chelæ deep chestnut, the former with a flavous patch above its postero-lateral edge; legs also deep castaneous, paler distally, with two obscure pale spots upon the femora; abdomen variegated with brown and yellow.

*Carapace* minutely granular, furnished with only a few coarse granules, the transverse and longitudinal groove deep; the area in front of the lateral eyes vertical laterally, convex mesially, and sloping downwards and forwards at an angle of about 45°, so that the anterior eyes look forwards; the distance between the median tubercle and the anterior border only slightly smaller than the longitudinal diameter of the tubercle; this border, when seen from above, narrow, very slightly emarginate, denticulate, the denticles larger at the side, directed horizontally; the apex of the median triangular frontal plate invisible from above; distance between the lateral ocular tubercles a little less than half the median length of the carapace and about twice the distance between either tubercle and the anterior border, and a little more than twice the distance between the tubercle and the lateral border.

*Mandibles* granular above, with two tubercles at the distal extremity of the basal joint, of which the external is the larger.

*Chelæ* long, slender, the distance between the lateral eyes about half the superior length of the femur, and less than the length of the tarsus; the latter smooth externally, the tibia and femur studded, but not very thickly, with coarse granules; the spines very long, the longest on the tibia greater than the distance between the lateral eyes, and much greater than the thickness of the tibia, the longest spine on the femur much

greater than the height of this segment and almost equal to the distance between the lateral ocular tubercles.

*Legs* very long: femur of the 1st twice and a half the width of the carapace; that of the 2nd longer than the width of the carapace by almost one-third of its length, considerably shorter than the femur of the 3rd, and scarcely longer than that of the 4th; tibia of the 2nd distinctly longer than the femur, that of the 3rd and 4th also very distinctly longer than the femora; in the 4th leg the 2nd and 3rd tibial segments are together longer than the protarsus, and two-thirds the length of the first tibial; the second tibial is about three-quarters the length of the third, and is equal to the distance between the lateral eyes.

*Measurements in millimetres.*—Total length 25; median length of carapace 9, width 13·5, distance between lateral eyes 4·5. *Chela*: height of femur 2·5, length 8·5, length of longest spine 3·5; width of tibia 3, length 11, length of longest spine 4·8; length of tarsus 5·5, of digit 5·2. *Legs*: femur of 1st 34, of 2nd 22, of 3rd 25, of 4th 21; tibia of 2nd 25, of 3rd 28, of 4th 27.

*Locality.* Haiti; a single example.

Resembling the preceding in having the eyes rather close together and in not being very coarsely granular, but easily recognizable by the strongly sloped frontal region of the carapace, the finer denticulation of its anterior border, longer chelæ and spines, much longer legs, &c.

Since describing the above dried example, I have come across two more specimens of the species, an adult female and a young, both preserved in alcohol, and both ticketed Brazil. The young example, a male, measures only 15 mm. long, and has the carapace only 8 mm. wide. It is paler in colour than the adults, and has the femora of the legs prettily mottled with yellow.

The adult female gives the following measurements:—Total length 32·5; carapace, median length 10·3, width 15, distance between eyes 5. *Chela*: length of femur 9, of tibia 12, of tarsus 7, of digit 6. *Legs*: femur of 1st 40, of 2nd 24·5, of 3rd 26·5, of 4th 23; the rest of the leg measurements are relatively the same as those of the type, which is a male.

TARANTULA LATIFRONS, sp. n. (Pl. XL. fig. 6.)

*Colour* fusco-castaneous; legs and abdomen lighter than the

carapace and chelæ; two postero-lateral spots on the carapace, and two, one posterior and lateral, the other submedian, on the principal terga. Upper surface of the trunk rather thickly studded with coarse granules.

*Carapace* flattish, its frontal portion lightly convex, and sloped downwards at an angle of less than  $45^{\circ}$ . The lateral eyes widely separated, the distance between them much greater than half the median length of the carapace, a little more than three times as great as the distance between one of the tubercles and the nearest point of the lateral border, and a little more than twice as great as the distance between the same tubercle and the antero-lateral border (angle). The median tubercle transverse, of medium height, separated from the anterior border by a space which is equal to quite twice its longitudinal diameter. The front border mesially depressed, very slightly emarginate, considerably overlapping the median process; the denticles moderately coarse laterally.

*Mandibles* almost smooth above, the external distal tubercle moderately prominent.

*Chelæ* moderately long, robust, granulation coarse on the femur, finer on the tibia; the distance between the lateral eyes equal to about four-fifths the length of the upperside of the tibia, and much greater than the length of the tarsus; the spines short, the longest on the tibia much less than the thickness of this segment, and scarcely half the length of the distance between the eyes; the longest on the femur less than the height of this segment, and rather shorter than the longest on the tibia. The spine-armature closely resembling that of *T. barbadosis*, but the upper edge of the tibia armed with only 7 spines, owing to the absence of the normal distal spinule, and the first superior spine on the tarsus very minute.

*Legs*: femur of 1st a little more than one-fourth greater than the width of the carapace, and a little more than twice its median length; the femur of the 2nd about equal to the width of the carapace, a little shorter than that of the 3rd, and a little longer than that of the 4th; tibia of the 2nd a little shorter than the femur, and just about twice the length of the protarsus; tibia of the 3rd a trifle longer than the femur, and more than twice the protarsus; the three tibial segments of the 4th a little longer than the femur, the second and third, taken together, about three-quarters the length of the first, and a little shorter

than the protarsal; the third tibial about twice the length of the second, which is about a third of the distance between the eyes.

*Measurements in millimetres.*—Total length 17·5; length of carapace along middle 8, width 12·5, distance between lateral eyes 5. *Chela*: height of femur 2·9, length 7, of its longest spine 2; width of tibia 3·6, length 9·5, of longest spine 2·5. *Legs*: femur of 1st 17, of 2nd 12, of 3rd 13, of 4th 11·3; tibia of 2nd 12, of 3rd 15·5, of 4th 12.

*Locality.* Haiti.

This species, perhaps, approaches nearer to *T. Goëssii* of Thorell than any known to me. The two seem to have the lateral eyes somewhat similarly placed, and in the last pair of legs the second and third tibial segments seem to bear the same proportion to one another. But Dr. Thorell, unfortunately, does not mention many of the characters upon which I think stress should be laid. His species, however, seems to differ in several points of measurement; for instance, the protarsus of the 4th leg is about one-third the length of the tibia (it is almost one-half the length in my species), and the tibia is considerably longer than the femur, whereas in my species the two segments are almost equal.

TARANTULA KEYSERLINGII, sp. n. (Pl. XL. fig. 7.)

*Colour* a uniform black.

Upper surface coarsely granular.

*Carapace*: distance between eyes greater than half the median length of the carapace; distance between each lateral eye-cluster and anterior border equal to half the distance separating the eyes, and much greater than the distance between the eyes in question and the lateral border; median tubercle transverse, separated from the anterior border by a wide space, which equals at least twice its longitudinal diameter. Anterior border lightly emarginate, coarsely dentate at the sides, concealing the frontal process.

*Chelæ* long, both tibia and femur coarsely granular above, robust; the tibia wider than its longest spine; the spine-arrangement almost exactly the same as in *T. barbadensis*, but owing to the greater length of the segments of the chelæ the spines on the femur and the superior proximal spines on the tibia are more isolated; moreover, the 1st superior tarsal spine is very minute; in its proximal half the tarsus is externally very distinctly granular.

*Legs* imperfect.

*Measurements in millimetres*.—Total length 27; carapace, width 11, median length 7·3, distance between eyes 4. *Chela*: length of femur 6·7, of tibia 9·5. *Legs*: femur of 1st 16·5, 2nd 12, 3rd 12·5, 4th 11·8.

Locality of type unknown; of a second smaller example, belonging apparently to the same species, Cuba.

The Cuban example, measuring 11 mm. long, with the carapace 7 mm. in width, appears to differ from the type merely in having the chelæ shorter, and therefore the spines closer together, and in having the external surface of the tarsus normally smooth.

In its character this species seems to lie between *T. scabra* and *T. latifrons*. From the latter it differs in having the lateral eyes less widely separated, the frontal border of the carapace narrower and more coarsely dentate, in the presence of 8 spines on the upper edge of the tibia of the chela, in the coarser granulation of this segment, &c. From *T. scabra*, *T. Keyserlingii* differs in having the median tubercle further from the anterior border, the lateral eyes more widely separated, the 1st spine on the tarsus of the chela smaller, and no spinule at the base of the 6th spine on the upper edge of the tibia.

This is very likely the Cuban species that is figured as *Phrynus palmatus* by Ramon de la Sagra.

TARANTULA VIRIDICEPS, sp. n. (Pl. XV. fig. 8.)

*Colour* (? young). Carapace and femora pale olive-green; abdomen darker, adorned with a pale spot marking each muscular impression, and one in the middle; mandibles, chelæ, tibiæ, and tarsi of legs ferruginous, the articulations on each side of the two principal joints of the legs of the 1st pair, *i.e.* between the femur and tibia, and the tibia and tarsus, yellow.

*Carapace* sparsely granular, with its frontal portion gently sloped downwards and forwards; the distance between the eyes less than half the median length of the carapace, and about twice the distance between a lateral cluster and the anterior edge, which is greater than the distance between the eye-cluster and the lateral edge; the median tubercle transverse, separated from the anterior margin by a space which equals nearly twice its longitudinal diameter; the anterior border mesially emarginate, with rounded lateral lobes, armed with about five teeth



on each side, considerably overlapping the frontal process, the apex of which is not visible from above.

*Mandibles* nearly smooth above, the two terminal tubercles slightly enlarged.

*Chelæ* robust, resembling those of *T. barbadensis*, but differing in the following particulars:—the spines on the trochanter are shorter, there are 9 spines instead of 8 on the upper edge of the tibia, the 3rd from the proximal end and the 4th from the distal end being the longest, as in *T. barbadensis*; but between these two spines there are *two* more in *T. viridiceps*, and only *one* in *T. barbadensis*.

*Legs* relatively longer as compared with the width of the carapace than in *T. barbadensis* (*cf.* measurements); 2nd tibia of 4th leg barely half the length of the 3rd, and equal to about one-third of the distance between the eyes.

*Measurements in millimetres*.—Total length 13 mm., width of carapace 9·3, median length 6, distance between eyes 3·5. *Chela*: length of femur 4·2, of tibia 6·2; width of latter 3, length of longest spine 2. *Legs*: femur of 1st 16, of 2nd 11, of 3rd 11·5, of 4th 9·8; tibia of 2nd 10, of 3rd 11·5, of 4th 11.

*Locality*. Bahamas (*Mrs. Blake*).

This species differs from all the West-Indian species known to me in the armature of the upper edge of the tibial segment of the chela.

In addition to the species described above the British Museum has one example allied to *T. Keyserlingii*, but too young to identify, from Jamaica (*P. H. Gosse*), and another allied to *T. tessellata*, from Dominica (*G. A. Ramage*).

The following species are, so far as I can ascertain, unknown to me:—

TARANTULA RENIFORMIS (*Linn.*), *Syst. Nat.* ed. 10, p. 619.

*Locality*. Antigua.

Judging from the proximity of Montserrat to Antigua, the species I have characterized as *T. Pallasii* (Bl.) will perhaps prove to be synonymous with *T. reniformis*.

TARANTULA MARGINE-MACULATA (*C. Koch*), *Die Arachn.* viii. p. 6, fig. 597.

*Locality*. West Indies.

This species should apparently fall under section *a*<sup>1</sup> of the above table, but nearer than this I am unable to place it.

TARANTULA GOËSI (Thorell), *Ann. Mus. Genov.* (2) vii. p. 530.  
*Locality.* St. Bartholomew.

ADDITIONAL NOTE to p. 526.—Whilst this paper was in the press I received from Mr. W. R. Elliott another specimen of a *Peripatus* from Dominica. It was found amongst rotten tree-stumps at an altitude of about 500 ft., close to the house on the Hatton Hall Estate, at Prince Rupert's.

Like the three examples already mentioned (p. 522), which were sent by Mr. Ramage from Laudat in the same island, this specimen possesses 30 pairs of legs. None of the posterior legs bear accessory tubercles, and we may conclude that the example is a female. The colour of the lower surface is greyish brown or a grey mud-coloured fawn; that of the upper surface is nearly the same, but a distinctly speckled pinkish tint is imparted to the skin by the brick-red colour of most of the primary papillæ. The pink tint fades away towards the anterior end behind the head, and the antennæ are approximately of the same colour throughout as this region of the body. The primary papillæ are, for the most part at least, contracted and conical, and I did not succeed in counting more than eight minor teeth on the inner blade of the jaw of the right side.

The length is 46 mm. and the width about 3·5. This specimen appears to me to be co-specific with those Dominican individuals identified above as *P. trinidadensis*.

## EXPLANATION OF THE PLATES.

### PLATE XXXVII.

Fig. 1. *Polyxenus longisetis*, sp. n.:  $\times 12$ .

2. *Glomeridesmus marmoreus*, sp. n.:  $\times 6$ .

- |     |   |   |   |                                 |
|-----|---|---|---|---------------------------------|
| 2a. | " | " | " | lateral view of head.           |
| 2b. | " | " | " | front view of head.             |
| 2c. | " | " | " | antenna.                        |
| 2d. | " | " | " | gnathochilarium.                |
| 2e. | " | " | " | depression above antenna.       |
| 2f. | " | " | " | lateral view of a tergite.      |
| 2g. | " | " | " | inferior view of a segment.     |
| 2h. | " | " | " | inferior view of last segment.  |
| 2i. | " | " | " | lateral view of the same.       |
| 2k. | " | " | " | leg of posterior pair.          |
| 2l. | " | " | " | penes, with legs of third pair. |
| 2m. | " | " | " | tip of penis.                   |

Fig. 3. *Stemmiulus ceylonicus*, Pocock, lateral view of head.

- 3 a. " " " gnathochilarium.  
 3 b. " " " lateral view of a tergite.  
 3 c. " " " inferior view of somite with left leg of  
 anterior pair removed.  
 4. *Siphonophora tenuicornis*, sp. n., head from the side.  
 5. *Siphonotus purpureus*, sp. n., head from before.  
 6. *Thyroproctus Townsendi*, gen. et sp. n., anterior end of body from the side  
 6 a. " " " posterior end from the side.  
 6 b. " " " posterior end from below.  
 6 c. " " " copulatory organ.

## PLATE XXXVIII.

Fig. 1. *Spirostreptus antillanus*, sp. n., ♀, head from the side:  $\times 1\frac{1}{2}$ .

- 1 a. " " " ♀, median segment from the side.  
 1 b. " " " ♀, anal segment from the side.  
 1 c. " " " ♂, head from the side:  $\times 1\frac{1}{2}$ .  
 1 d. " " " ♂, copulatory apparatus from the front.  
 2. *Rhinocricus Gossei*, sp. n., copulatory apparatus.  
 3. " *macropus*, sp. n., anterior end from the side:  $\times 1\frac{1}{2}$ .  
 3 a. " " " two median segments from the side.  
 3 b. " " " posterior end from the side.  
 3 c. " " " posterior end from above.  
 3 d. " " " copulatory apparatus.  
 4. " *arboreus* (Sauss.), copulatory apparatus.  
 5. " *Maltzani*, sp. n., posterior end of body:  $\times 2$ .  
 5 a. " " " copulatory apparatus.  
 5 b. " " " anterior legs of ♂.  
 6. " *solitarius*, sp. n., copulatory apparatus.  
 7. " *consociatus*, sp. n., copulatory apparatus.  
 8. " *leucostigma*, sp. n., copulatory apparatus.  
 9. " *serpentinus*, sp. n., copulatory apparatus.  
 10. " *vincentii*, sp. n., copulatory apparatus.  
 11. " *grenadensis*, sp. n., copulatory apparatus.  
 12. " *sabulosus*, sp. n., copulatory apparatus.

## PLATE XXXIX.

Fig. 1. *Cyclodesmus porcellanus*, sp. n., anterior end from the side.

- 1 a. " " " posterior end from the side.  
 2. *Cryptodesmus vincentii*, sp. n., anterior end from above:  $\times 6$ .  
 2 a. " " " 9th segment from above.  
 2 b. " " " posterior segment from above.  
 2 c. " " " head from before.  
 2 d. " " " left copulatory foot from outside.  
 3. *Platyrrhachus luciae*, sp. n., anterior end from above:  $\times 2$ .  
 3 a. " " " 11th and 12th segments from above:  $\times 2$ .  
 3 b. " " " posterior end from above:  $\times 2$ .

Fig. 3 c. *Platyrrhachus lucia*, sp. n., tail.

- 3 d.       "       "       "       copulatory foot from outside.  
 4.   *Odontopeltis vincentii*, sp. n., anterior end from above:  $\times 6$ .  
 4 a.       "       "       "       11th and 12th segments from above:  $\times 6$ .  
 4 b.       "       "       "       posterior end from above:  $\times 6$ .  
 4 c.       "       "       "       left copulatory foot from below.  
 4 d.       "       "       "       copulatory foot from the side.  
 5.       "       *morantus*, Karsch, left copulatory foot from outside.  
 5 a.       "       "       "       14th and 15th segments from above:  $\times 8$ .  
 6.       "       *verrucosus*, sp. n., anterior end from above:  $\times 6$ .  
 6 a.       "       "       "       11th and 12th segments from above:  $\times 6$ .  
 6 b.       "       "       "       posterior end from above:  $\times 6$ .  
 6 c.       "       "       "       right copulatory foot from outside.  
 6 d.       "       "       "       right copulatory foot from inside.  
 7.       "       *formosus*, sp. n., 11th and 12th segments:  $\times 6$ .  
 8.       "       *mammatus*, sp. n., 11th and 12th segments:  $\times 6$ .  
 8 a.       "       "       "       left copulatory foot from inside.  
 8 b.       "       "       "       apex of same from above.

#### PLATE XL.

Fig. 1. *Tarantula barbadensis*, sp. n., carapace and chela:  $\times 1\frac{1}{2}$ .

2.       "       *tessellata*, sp. n., nat. size, ♂.  
 3.       "       *Pallasii*, Blanch., carapace and chela:  $\times 1\frac{1}{2}$ .  
 3 a.       "       "       "       distal spines of upperside of tibia.  
 4.       "       *spinimana*, sp. n., carapace and chela:  $\times 1\frac{1}{2}$ .  
 4 a.       "       "       "       tarsus of chela from below.  
 5.       "       *longipes*, sp. n., carapace and chela:  $\times 1\frac{1}{2}$ .  
 6.       "       *latifrons*, sp. n., carapace and chela:  $\times 1\frac{1}{2}$ .  
 7.       "       *Keyserlingii*, sp. n., carapace and chela:  $\times 1\frac{1}{2}$ .  
 8.       "       *viridiceps*, sp. n., carapace and chela:  $\times 1\frac{1}{2}$ .
-

Catalogue of the described Neuroptera Odonata (Dragonflies) of Ceylon, with Descriptions of New Species. By W. F. KIRBY, F.L.S., F.E.S., of the Natural History Museum.

[Read 7th December, 1893.]

(PLATES XLI. & XLII.)

COL. YERBURY, who has lately returned from Ceylon, bringing with him a considerable collection of insects of various orders, has liberally handed over the bulk of them to the Natural History Museum. His collection of Dragonflies is so extensive that I have thought it would be useful to draw up a complete list of the species at present known to inhabit that island, similar to the Catalogue of the Hemiptera of Ceylon, which I had the honour of laying before the Linnean Society two years ago†. At present I am able to enumerate seventy-six species, of which Col. Yerbury has succeeded in obtaining fifty-five. Of these I have described ten as new to science, and one of them is referable to a new and interesting genus.

The first list of Cinghalese Odonata was published by the late Dr. Hagen in vol. viii. of the 'Verhandlungen der k.-k. zool.-bot. Gesellschaft in Wien' (1858, pp. 478-481). He enumerated twenty-eight species as follows, the names under which they appear in the present list being given in the second column (those marked \* are only manuscript names; and all except those marked † are noted as from Rambodde):—

HAGEN.	KIRBY.
†Calopteryx(Neurobasis)chinensis, L.	Neurobasis chinensis, L.
Euphæa splendens, Hagen.	Pseudophæa splendens, Selys.
†Micromerus lineatus, Burm.	Micromerus lineatus, Burm.
*†Trichocnemys serapica, Selys.	Copera serapica, Selys.
*Lestes elata, Hagen.	Lestes elatus, Selys.
*L. gracilis, Hagen.	L. gracilis, Selys.
Agrion coromandelianum, F.	Ceriagrion cerinorubellum, Brauer.
*A. tenax, Hagen.	Disparoneura tenax, Selys.
*A. hilare, Hagen.	Platysticta hilaris, Selys.
*A. velare, Hagen.	Agriocnemis velaris, Selys.
*A. delicatum, Hagen.	Micronympha aurora, Brauer.
†Gynacantha subinterrupta, Ramb.	Acanthagyna subinterrupta, Ramb.
Epophthalmia vittata, Burm.	Epophthalmia vittata, Burm.
Zygomma petiolatum, Ramb.	Zygomma petiolatum, Ramb.

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† Journ. Linn. Soc., Zool. xxiv. pp. 72-176.

## HAGEN.

- Acisoma panorpoides*, *Ramb.*  
*Libellula tillarga*, *F.*  
*L. variegata*, *L.*  
*L. sabina*, *Dru.*  
*L. congener*, *Ramb.*  
*L. soror*, *Ramb.*  
*L. aurora*, *Burm.*  
 \**L. violacea*, *Nietn.*  
 \**L. perla*, *Hagen.*  
*L. sanguinea*, *Burm.*  
*L. trivialis*, *Ramb.*  
*L. contaminata*, *F.*  
*L. equestris*, *F.*  
*L. nebulosa*, *F.*

## KIRBY.

- Acisoma panorpoides*, *Ramb.*  
*Tholymis tillarga*, *F.*  
*Rhyothemis variegata*, *Joh.*  
*Orthetrum sabina*, *Dru.*  
*Potamarcha obscura*, *Ramb.*  
*Crocothemis soror*, *Ramb.*  
*Trithemis aurora*, *Burm.*  
 — ?  
 — ?  
*Urothemis sanguinea*, *Burm.*  
*Trithemis trivialis*, *Ramb.*  
*Brachythemis contaminata*, *F.*  
*Neurothemis equestris*, *Dru.*  
*Diplacodes nebulosa*, *F.*

In the next year of the 'Verhandlungen' (vol. ix. 1859, pp. 206, 207) Hagen published the following supplementary list:—

- |   |   |
|---|---|
| † <i>Calopteryx</i> ( <i>Vestalis</i> ) <i>amœna</i> , <i>Hagen.</i>    | <i>Vestalis apicalis</i> , <i>Selys.</i>      |
| * <i>Lestes orientalis</i> , <i>Hagen.</i>                              | <i>Lestes orientalis</i> , <i>Selys.</i>      |
| * <i>Disparoneura maculata</i> , <i>Nietn.</i>                          | <i>Platysticta maculata</i> , <i>Selys.</i>   |
| ( <i>D. tenax</i> , <i>Hagen</i> = <i>Agrion</i> t., above.)            |   |
| ( <i>D. hilaris</i> , <i>Hagen</i> = <i>A. hilare</i> , above.)         |   |
| * <i>D. centralis</i> , <i>Hagen.</i>                                   | <i>Disparoneura centralis</i> , <i>Selys.</i> |
| ( <i>Gynacantha subinterrupta</i> , <i>Ramb.</i> ,<br>additional note.) |   |
| † <i>Libellula stylata</i> , <i>Ramb.</i>                               | <i>Tranea stylata</i> , <i>Ramb.</i>          |
| † <i>L. flavescens</i> , <i>Fabr.</i>                                   | <i>Pantala flavescens</i> , <i>F.</i>         |
| † <i>L. rufa</i> , <i>Ramb.</i>   | <i>Erythemis rufo</i> , <i>Ramb.</i>          |

This raises the number to thirty-five species.

Walker, in Tennent's 'Natural History of Ceylon' (1861), copies Hagen's first list, adding only *Libellula marcia*, *Dru.*, *flavescens*, *F.*, and *viridula*, *Beauv.* But these are not real additions, for *L. marcia*, *Dru.* = *variegata*, *L.*; and *L. flavescens* and *viridula* are synonyms of one species (which had already been included in Hagen's second list). Motschulsky (*Bull. Soc. Nat. Moscou*, xxxvi. no. iii. p. 8, 1863) merely quotes Walker's list, with the accidental omission of *Libellula aurora*, *Burm.*

Since this time some of Hagen's MS. species have been described by Baron de Selys-Longchamps, and several other species have been recorded or described as new from Ceylon by De Selys, Hagen, Brauer, Karsch, and myself. But the only special paper on the subject is one of my own, "On some

Neuroptera Odonata (Dragonflies) collected by Mr. E. E. Green in Ceylon" (Proc. Zool. Soc. Lond. 1891, pp. 203-206), in which fourteen species are enumerated, three of which were believed at the time to be new.

In the following list all the species of which the British Museum possesses specimens from Ceylon are marked (\*), and those contained in Col. Yerbury's collection (+). The localities mentioned are all given on Col. Yerbury's authority, except those for which other authorities are quoted.

I am indebted to Baron de Selys-Longchamps for the names of a few additional species not previously recorded from Ceylon.

## LIBELLULIDÆ.

### LIBELLULINÆ.

#### \*†1. THOLYMIS TILLARGA.

*Libellula tillarga*, *Fabr. Ent. Syst. Suppl.* p. 235 (1798).

Trincomali, Oct. 6 & 23, 1891. Kanthalai, Nov. 11, 16, 1891.

Henaratgoda, May 5, 1892.

Rambodde (*Hagen*).

A common East-Indian species.

#### \*†2. PANTALA FLAVESCENS.

*Libellula flavescens*, *Fabr. Ent. Syst. Suppl.* p. 285 (1798).

*Libellula viridula*, *Beauv. Ins. Afr. Amér.* p. 69, pl. 3. f. 4 (1805).

Trincomali, Oct. 12, Nov. 10 & 20, Dec. 14, 1890; Nov. 11 and Dec. 17, 1891. Mahagany, near Trincomali, Sept. 20, 1891. Pigeon Island, Nov. 18, 1891.

An abundant species throughout the warmer parts of the world. The only specimen supposed to have occurred in Europe is thus mentioned by Curtis: "*Libellula Sparshalli*, Dale's MSS. Taken at Horning in 1823 by the late Mr. J. Sparshall; it is very similar to a Chinese species" (Brit. Ent. fol. 712). But, so far as I am aware, no description of the insect was ever published under this name.

#### \*†3. HYDROBASILEUS EXTRANEUS. (Pl. XLI. fig. 1, ♀.)

*Tramea extranea* (*Hagen*), *Karsch, Berl. ent. Zeitschr.* xxxiii. p. 351 (1890).

♂. Long. corp. 47 millim.; app. anal. 3 millim.; exp. al. 82 millim.; long. pter.  $3\frac{1}{2}$  millim.

♀. Long. corp. 45 millim.; exp. al. 90 millim.; long. pter. 5 millim.

Uniform testaceous-yellow in both sexes, with all the abdominal sutures and carinæ black; all the wings strongly tinged with yellow, and with the pterostigma pale yellow; fore wings with the triangle crossed by two nervures, and the subtriangular space by one or two, or none; a brown band runs from the anal angle over the extremity of the subbasal sectors, not quite reaching the lower part of the hind margin. It is narrowest nearest to the anal angle, and its upperside is more or less irregular. The anal appendages are rather short and tipped with black; the appendages of the second segment in the male are conspicuous.

Henaratgoda, Feb. 7, 1892 (♀). Mahagany, March 6, 1892 (♂).

Nalanda (*Fruhstorfer*).

Col. Yerbury brought home one specimen of each sex. I have added a brief description of the insect, as the few particulars given by Dr. Karsch are barely sufficient for its identification. It is said to occur at Penang and in Celebes, as well as in Ceylon.

\*†4. *TRAMEA STYLATA*.

*Libellula stylata*, *Ramb. Ins. Névr.* p. 37 (1842).

Trincomali, Sept. 13, 1890; Nov. 1 & 11, 1891.

Originally described from Bombay.

\*†5. *TRAMEA BURMEISTERI*.

*Tramea Burmeisteri*, *Kirb. Trans. Zool. Soc. Lond.* xii. p. 316 (1889).

*Libellula chinensis*, *Burm. Handb. Ent.* ii. p. 852 (1839), *nec De Geer*.

Trincomali, Nov. 16, 1890. Mahagany, Nov. 1 & 10, 1891.

Not an uncommon species in India and Ceylon. The specimens from Ceylon are generally rather darker than the others.

I may note here that Dr. Karsch, in one of his recent papers, accuses me of omitting *Trithemis erythræa*, Brauer, from Mauritius, from my Catalogue of Neuroptera Odonata. I find no such species in the writings of that author; but I find two species, *Tramea africana* and *Tramea erythræa*, which were omitted by Dr. Brauer himself in a general list which he published subsequently. Both these will be found under *Tramea* on p. 4 of my Catalogue, and I presume that the latter is what Karsch calls "*Trithemis*" *erythræa*.



## \*†6. RHYOTHEMIS VARIEGATA.

*Libellula variegata*, *Joh. Amœn. Acad.* vi. p. 412 (1764).

*Libellula marcia*, *Drury, Ill. Ex. Ent.* ii. pl. 45. fig. 3 (1773).

Trincomali, Nov. 1 & 11, 1891. Kanthalai, Nov. 15, 1891.

Rambodde (*Hagen*).

A common East-Indian species.

## 7. RHYOTHEMIS PHYLLIS.

*Libellula phyllis*, *Sulz. Gesch. Ins.* pl. xxviii. fig. 2 (1776).

A common East-Indian species, noted by Baron de Selys-Longchamps as occurring in Ceylon.

## 8. RHYOTHEMIS OBSOLESCENS.

*Rhyothemis obsolescens*, *Kirb. Trans. Zool. Soc. Lond.* xii. p. 321 (1889).

Described from Borneo; stated by Baron de Selys-Longchamps (*in litt.*) to occur in Ceylon.

## \*†9. RHYOTHEMIS LANKANA, sp. n.

Long. corp. 24 millim.; exp. al. 36 millim.; long. pter.  $1\frac{1}{2}$  millim.

*Male*. Deep violet-black; head steel-blue, with the clypeus and labrum bordered beneath with testaceous. Wings clear hyaline, with pale yellowish pterostigma; dark brown towards the base, with violet reflections; the centre of most of the cells lighter, a more or less hyaline basal streak below the principal radius; and on the hind wings 2 or 3 short subhyaline stripes running towards the inner margin. Fore wings with 1 cross-nervure in the triangle; post-triangular cells, 3 or 4 in the first row, followed by a series first of 3 and then of 2, only increasing to 4 on the hind margin; 7 antenodal and 6 or 7 postnodal cells, the last antenodal and 2 first postnodals not continuous; the postnodals rather irregular in the lower space; subtriangular space consisting of 3 cells. On the fore wings the opaque portion extends to between the 4th and 5th antenodal cross-nervures; it projects a little on the lower subcostal space, and then runs obliquely just beyond the triangle, but does not quite extend to the inner margin. Hind wings with 5 antenodal and 6 postnodal cross-nervures, the first two postnodals not continuous; the opaque portion extends to the nodus, without a break, and runs down to the hind margin almost beneath it, but is twice

deeply indented. Anal appendages hardly longer than the last segment of the abdomen.

Described from a single male specimen taken at Udagama on April 26, 1892.

The description being made from a single specimen may require ultimate modification. The insect is closely allied to *R. triangularis*, Kirb., from Borneo; but the latter species has three rows of post-triangular cells, increasing instead of decreasing on the fore wings.

#### 10. NEUROTHEMIS CEYLANICA.

*Neurothemis ceylanica*, Brauer, *Verhandl. d. k.-k. zool.-bot. Ges. in Wien*, xvii. p. 11 (1867).

Usually considered to be one of the local races of *N. fluctuans*, Fabricius.

#### \*†11. NEUROTHEMIS TULLIA.

*Libellula tullia*, Drury, *Ill. Ex. Ent.* ii. pl. 46. fig. 3 (1773).

*Libellula equestris*, Fabr. *Spec. Ins.* i. p. 523 (1781).

Hot Wells, Trincomali: adult males, Feb. 4, July 13, Sept. 13 & 27, 1891; immature males, Sept. 27, Oct. 8 & 15, 1891; females, apparently much scarcer, July 13, 1890, Oct. 8, 1891. Also at Tamblagam, Oct. 5, 1891.

Rambodde (*Hagen*).

A common East-Indian species.

#### \*†12. NEUROTHEMIS INTERMEDIA.

*Libellula intermedia*, Ramb. *Ins. Névr.* p. 91 (1842).

Trincomali, Nov. 10. Andankulam, Nov. 12, 1891. Kanthalai, March 8, 1892.

#### \*†13. TRITHEMIS TRIVIALIS.

*Libellula trivialis*, Ramb. *Ins. Névr.* p. 115 (1842).

Trincomali, July 13, 27, 1890; July 12, Sept. 2, 12, 15, Oct. 23, Nov. 11, 1891.

Rambodde (*Hagen*); Kandy (*Green*).

A common East-Indian species.

#### \*†14. TRITHEMIS AURORA.

*Libellula aurora*, Burm. *Handb. Ent.* ii. p. 859 (1839).

*Trithemis aurora*, Brauer, *Verh. zool.-bot. Ges. Wien*, xviii. p. 177 (1868); *Selys, Ann. Mus. Genov.* xxx. p. 465 (1891).

*Trithemis intermedia*, *Kirb. Proc. Zool. Soc. Lond.* 1886, p. 327, pl. 33, fig. 4.

*Trithemis Yerburi*, *Kirb. Cat. Neur. Odon.* p. 18 (1890).

Hot Wells, Trincomali, July 13, 27, 1890; Sept. 13, Nov. 6, 13, 1891. Kanthalai, July 31, 1891.

Rambodde (*Hagen*); Pundaloya (*Green*).

A common East-Indian species.

\*15. *TRITHEMIS KIRBII*.

*Trithemis Kirbii*, *Selys, Ann. Mus. Genov.* xxx. p. 465 (1891).

*Trithemis aurora*, *Kirb. Proc. Zool. Soc. Lond.* 1886, p. 327, pl. 33, fig. 3.

Recorded from India and Ceylon.

\*†16. *TRITHEMIS FESTIVA*.

*Libellula festiva*, *Ramb. Ins. Névr.* p. 92 (1842).

*Libellula infernalis*, *Brauer, Verh. zool.-bot. Ges. Wien*, xv. p. 507 (1865).

Trincomali, Aug. 19, Sept. 18, Dec. 6, 1890. Hot Wells, Nov. 8, 1891.

\*†17. *BRACHYTHEMIS CONTAMINATA*.

*Libellula contaminata*, *Fabr. Ent. Syst.* ii. p. 382 (1793).

Trincomali, July 24, 1890; Oct. 6 and Nov. 11, 1891. Andankulam, Oct. 5, 1891. Kanthalai, Nov. 15, 1891.

Rambodde (*Hagen*).

A common East-Indian species.

"A large Asilid (*Promachus maculatus*, Loew?) was taken preying on this species" (*Yerbury*).

\*†18. *CROCOTHEMIS SOROR*.

*Libellula soror*, *Ramb. Ins. Névr.* p. 82 (1842).

Andankulam, Oct. 5, 1891. Tanglegam, Oct. 5, 1891. Kanthalai, March 8, 1892. Trincomali and Mahagany, July 27, Aug. 5, 1890; Sept. 16, Oct. 6, Nov. 24, Dec. 20, 1891.

Rambodde (*Hagen*).

Common in India and Ceylon.

\*†19. *BRACHYDIPLAX SOBRINA*.

*Libellula sobrina*, *Ramb. Ins. Névr.* p. 114 (1842).

*Brachydiplax sobrina*, *Selys, Ann. Mus. Genov.* xxx. p. 449 (1891).

*Brachydiplax indica*, *Kirb. Trans. Zool. Soc. Lond.* xii. p. 329, pl. 54, fig. 9 (1889).

*Brachydiplax Gestroi*, *Selys, Ann. Mus. Genov.* xxx. p. 451 (1891).

*Hab.* Trincomali, Aug. 3, 5, Sept. 13, Oct. 5, 1890. Tangle-gam and Andankulan, Oct. 5, 1891.

Rambodde (*Hagen*).

\*†20. *UROTHEMIS SANGUINEA*.

*Libellula sanguinea*, *Burm. Handb. Ent.* ii. p. 858 (1839).

*Libellula signata*, *Ramb. Ins. Névr.* p. 117 (1842).

Kanthalai, Nov. 15, 1891.

Rambodde (*Hagen*).

Occurs in India and Ceylon.

\*†21. *UROTHEMIS VITTATA*, sp. n. (Pl. XLII. fig. 2, ♀.)

Long. corp. 38–40 millim.; exp. al. 67 millim.; long. pter.  $2\frac{1}{2}$  millim.

Reddish ochreous; labrum, the ocellar suture, more or less of the pleural sutures, the legs, except the base of the femora, a broad stripe on the back of the abdomen, widened at each end of the segments, and interrupted by the sutures, but not by the carinæ, and two spots at the ends of the segments, and sometimes also in the middle, beneath, black. Head black behind the eyes, with a yellow space in the middle and two on each side. Wings hyaline, with ochreous nervures in the male, browner in the female; membranule whitish; hind wings tinged with saffron at the base. Fore wings with 6 antenodal and 5 postnodal nervures, the two first postnodals not continuous, and the first very oblique; hind wings with 5 antenodals and postnodals, the two first postnodals not continuous. Pterostigma yellowish, between brown nervures, covering a little more than one cell. All the triangles open, and followed by two rows of cells, increasing; the outer side of that on the fore wings showing a slight tendency to form an angle towards the nervure dividing the two first cells, subtriangular space with three cells; triangle of hind wings rather pointed, its base extending nearer the base of the wings than the arculus. Anal appendages of male rather shorter than the last two segments.

Trincomali, Sept. 10, 1891 (♀).

The male is described from an Indian specimen from Saunders's collection. Not closely allied to any other species; resembles some of the *Corduliinæ* in coloration, to which subfamily *Urethemis* has some affinity.

## \*†22. LATHRECISTA SIMULANS.

*Agrionoptera simulans*, *Selys, Ann. Mus. Genov.* xiv. p. 300 (1879).

Trincomali and Mahagany, Oct. 12, 1890; Sept. 20, Oct. 20, Nov. 20, 28, Dec. 17, 1891; March 6, 1892. Velvery, Nov. 25, 1891. Tamblegam, Nov. 19, 1891.

Recorded from Ceylon and Malacca.

## \*†23. POTAMARCHA OBSCURA.

*Libellula obscura*, *Ramb. Ins. Névr.* p. 64 (1842).

*Libellula congener*, *Ramb. l. c.* p. 70 (1842).

*Potamarcha obscura*, *Karsch, Berl. ent. Zeitschr.* xxxiii. p. 370 (1890).

Trincomali, Sept. 16, Nov. 10, Dec. 16, 1891. Mahagany, Sept. 20, 1891. Velvery, Oct. 25, 1891.

Rambodde (*Hagen*).

Recorded from the Philippines, Java, and Malacca, as well as from Ceylon. The British Museum also possesses specimens from India and Celebes.

## BRADINOPYGA, g. n.

Frontal tubercle concave; abdomen rather slender, hardly thickened at base, a little shorter than the hind wings; segments 2-4 strongly carinated; pterostigma pale at both ends. Fore wings with 12-13 antenodal and 8-9 postnodal cross-nervures, triangle traversed by 1 nervure, sometimes a little beyond the level of that of the hind wings, followed by 3 rows of cells, increasing, the base slightly oblique, no supratrangular nervures; 1 cross-nervure in the male in the lower basal cell, 2 in the female, nodal and subnodal sectors very slightly waved: hind wings with 8 or 9 antenodal, and 9 or 10 postnodal nervures, triangle followed by 3 rows of cells, increasing, sectors of the triangle separated at base. Anal appendages slender, pointed, those of the female as long as the 9th segment, those of the male somewhat longer; lower appendage of the male broad, spatulate, nearly as long as the others.

All the other characters as in my definition of *Hemistigma*.

This genus is evidently the Asiatic representative of the African *Hemistigma*.

## \*†24. BRADINOPYGA STIGMATA. (Pl. XLI. fig. 3, ♂.)

Long. corp. 36-40 millim.; exp. al. 65 millim.; long. pter. 4 millim.

*Male*. Dull testaceous; head with the labrum yellow, and the

labium paler yellow; mandibles and suture of the labium black; occiput spotted with black and tawny. Sutures of the thorax, and a transverse stripe above, black; sides of the thorax and pleura with several rather ill-defined pale spots. Abdomen with the sutures black, and mottled and blotched with black, with pale spots and streaks on the sides of segments 3-7. Legs with the tarsi and front tibiæ black. Wings hyaline, with blackish nervures; costal nervure tawny on the outside; pterostigma black in the middle, whitish or yellowish at each extremity. Anal appendages yellow.

*Female* similar, but with the blackish markings much more extended, especially on the abdomen, where at least the hinder half of all the segments is black; the legs are also much varied with brown.

*Hab.* Trincomali, July 7, 1890.

Col. Yerbury's specimen is a male; the female described is labelled "India" with doubt.

#### 25. ZYXOMMA PETIOLATUM.

*Zyxomma petiolatum*, *Ramb. Ins. Névr.* p. 30, pl. 2. fig. 4 d (1842); *Hag. Verh. zool.-bot. Ges. Wien*, viii. p. 479 (1858).

Rambodde (*Hagen*).

A common Indian species. It is likewise recorded from Celebes; but as there are several closely allied forms of the genus, it is not unlikely that the Celebesian specimens may belong to a distinct species.

#### \*†26. ORTHETRUM SABINA.

*Libellula sabina*, *Drury, Ill. Ex. Ent.* i. pl. 48. fig. 4 (1773).

Hot Wells, Trincomali, Sept. 11, 13, 1891.

Rambodde (*Hagen*).

A very common and widely distributed species throughout the tropics of the Old World.

#### \*†27. ORTHETRUM OBLITUM. (Pl. XLII. fig. 3, ♀.)

*Libellula oblita*, *Ramb. Ins. Névr.* p. 123 (1842).

Hot Wells, Trincomali, Aug. 3, 1890. Ververy, Dec. 27, 1891.

Also occurs in India and Australia.

#### \*†28. ORTHETRUM PRUINOSUM.

*Libellula pruinosa*, *Burm. Handb. Ent.* ii. p. 858 (1839).

Trincomali, Sept. 15, Oct. 8, Nov. 24, 1891. Kanthalai, March 8, 1892.

Also recorded from India, China, Philippines, Java, Sumatra, and Borneo.

Pundaloya (*Green*).

\*†29. ORTHETRUM CARNATICUM.

*Libellula carnatica*, *Fabr. Ent. Syst. Suppl.* p. 284 (1798).

*Orthetrum carnaticum*, *Kirb. Proc. Zool. Soc. Lond.* 1891, p. 204, t. 20. f. 1.

Hot Wells, Trincomali, Sept. 27, 1891. Kitti Otu, Feb. 21, 1892. Kanthalai, March 8, 1892. Haputale, June 8, 1892. Kandy, May 18, 1892. Hiaduma, April 29, 1892.

Pundaloya (*Green*).

A common Indian species.

Fabricius places this species between *Orthetrum cancellatum* and *Sympetrum pedemontanum*. There is nothing in the description to fix the species positively; but if, as is most probable, Fabricius intended to compare the insect with *O. cancellatum*, then I think my identification is most probable. De Selys identifies *L. carnatica* with *Trithemis festiva* (*anted*, No. 16).

30. ORTHETRUM GLAUCUM.

*Libellula glauca*, *Brauer, Verh. zool.-bot. Ges. Wien*, xv. p. 1012 (1865).

Balangodde (*Brauer*).

I have not yet received any specimens which I can identify with this species.

\*†31. ORTHETRUM TRICOLOR, sp. n.

Long. corp. 41 millim.; exp. al. 61 millim.; long. pter. 4 millim.

*Male*. Head yellow, frontal tubercle black, truncated, the black colour extending on the sides of the clypeus in front of the eyes; occiput yellow, with black markings; thorax yellow, with all the sutures black, and black shoulder-stripes, not quite complete behind. Abdomen pulverulent blue, tricarinate, segments 2 and 3 transversely carinated, segments 1 and 2 spotted with yellow above, and segments 1-3 with an interrupted yellow stripe on the sides; legs black, front femora yellow beneath. Wings hyaline, with black nervures, costal nervures bisected by a pale line: fore wings with 12 antenodal (continuous) and 8 or 9 postnodal cross-nervures, the first 2 postnodals not continuous; pterostigma rather long, yellow between black nervures, the uppermost thickest; triangle traversed by one nervure, and

followed by 3 rows of cells, increasing; nodal sector waved; one supratrangular nervure; subtriangular space consisting of 3 cells: hind wings with 9-10 antenodal and 9-10 postnodal cross-nervures, the first 3 postnodals not continuous; triangle followed by 3 rows of cells, increasing, the sectors slightly separated. Anal appendages rather longer than the 9th segment; a yellow spot on the 10th segment above.

Kandy, May 30, 1892.

### 32. ERYTHEMIS RUFA.

*Libellula rufa*, *Ramb. Ins. Névr.* p. 71 (1842).

Recorded from Ceylon, Java, Celebes, and Burmah. I have seen no specimens which I can identify with this species.

### \*†33. DIPLOCODES NEBULOSA.

*Libellula nebulosa*, *Fabr. Ent. Syst.* ii. p. 379 (1793).

Trincomali, July 17 & 20, Sept. 12 & 13, 1891. Andankulam, Sept. 5, Oct. 7, 1891. Kanthalai, March 3, 1892. Perriyakulam (=great tank), March 27, 1892.

Rambodde (*Hagen*).

A very common Indian species.

### \*†34. ACISOMA PANORPOIDES.

*Acisoma panorpoides*, *Ramb. Ins. Névr.* p. 28 (1842).

Kanthalai, July 31, 1890. Andankulam, Oct. 5 & 7, 1891.

Rambodde (*Hagen*).

Common in India, China, and Ceylon. It is probable that the allied African forms are distinct.

### 35. TETRATHEMIS FRUHSTORFERI.

*Tetratthemis Fruhstorferi*, *Karsch, Ent. Nachr.* xv. p. 321 (1889).

Belihul-Oya (*Karsch*).

### \*†36. TETRATHEMIS YERBURII. (Pl. XLI. fig. 4, ♀.)

Long. corp. 26-28 millim.; exp. al. 44-51 millim.; long. pter. 2 millim.

Inky black; head with the vertex metallic green, a small yellow spot on each side above the antennæ and on the lower angles of the vertex; ocelli orange, nasus and rhinarium yellow; all the lower mouth-parts black, except the sides of the labium. Thorax with the collar, a short dash on the median line, three broad pleural stripes, one before and two below the wings, the septa, pnystega, and metapnystega yellow; abdomen with yellow



spots on the sides of segments 2-7; the first three are double, being divided by the carinæ (the carina on the 4th segment is nearly obsolete above); the spots are more or less produced upwards, and those on the 7th segment nearly meet on the back; the spot in front of the carina on segment 4 and that on the sides of segment 6 are obsolete in the male. Wings clear hyaline, slightly iridescent, with a smoky patch at the tip of each; pterostigma rather thick, dark brown, covering two cells; fore wings with 9-10 antenodal and 5-6 postnodal cross-nervures; hind wings with 8 antenodals and 5-6 postnodals; first postnodal on all the wings not continuous; trapeziums of fore wings and triangles of hind wings open; one supratrangular nervure and 2 cross-nervures in lower basal cell on all the wings; anal appendages of male as long as the 9th and 10th segments together.

Kandy, May 31 and June 30, 1892.

Described from three specimens—two males, and a female taken *in coitu* with one of them. The description given above, with the slight exceptions indicated, applies to both sexes.

Differs from all previously described species in the hyaline wings with clouded tips.

#### CORDULINÆ.

##### \*†37. EPOPHTHALMIA CYANEOCEPHALA.

*Epophtalmia cyaneocephala*, Hagen, *Verh. zool.-bot. Ges. Wien*, xvii. p. 60 (1867).

*Epophtalmia vittata*, Hagen, *l. c.* viii. p. 479 (1858), *nec* Burm.

Tamblegam, Oct. 5, 1891.

Colombo (*Brauer*); Rambodde (*Hagen*).

#### ÆSCHNIDÆ.

##### GOMPHINÆ.

##### GOMPHINA.

##### 38. ÆSHNA CEYLONICA.

*Gomphus* (?) *ceylonicus*, Selys, *Bull. Acad. Belg.* (2) xli. p. 455 (1878).

Rambodde (*Nietner*).

##### 39. ANISOGOMPHUS NIETNERI.

*Gomphus* (?) *Nietneri*, Selys, *Bull. Acad. Belg.* (2) xli. p. 449 (1878).

Rambodde (*Nietner*).

## ÆSCHNINÆ.

## \*†40. ICTINUS RAPAX.

*Diastatomma rapax*, *Ramb. Ins. Névr.* p. 169 (1842).

Periyakulum, Nov. 11, 1891. Huldamura, June 10, 1892.

A common East-Indian species.

## \*†41. ANAX GUTTATUS.

*Anax guttatus*, *Burm. Handb. Ent.* ii. p. 840 (1839).

Trincomali, Nov. 24, 1891.

A common East-Indian species.

## \*†42. HEMIANAX EPHIPPIGER.

*Æschna ephippigera*, *Burm. Handb. Ent.* ii. p. 840 (1839).

Hot Wells, Trincomali, Jan. 14, 1892.

Common throughout the warmer parts of the Old World.

## 43. ACANTHAGYNA SUBINTERRUPTA.

*Gynacantha subinterrupta*, *Ramb. Ins. Névr.* p. 212 (1842).

*Gynacantha subinterrupta*, *Hagen, Verh. zool.-bot. Ges. Wien*, viii. p. 479 (1858), ix. p. 207 (1859).

Negombo (*Nietner*).

According to *Nietner* (quoted by *Hagen*) this species flies in the evening. It is found in Java, Bouru, Celebes, Papua, &c., as well as in Ceylon.

## \*44. ACANTHAGYNA FURCATA.

*Gynacantha furcata*, *Ramb. Ins. Névr.* p. 210 (1842).

There are specimens of this species in the British Museum Collection from India, Ceylon (*Wenham's* Collection), and Borneo.

## AGRIONIDÆ.

## AGRIONINÆ.

## \*†45. NEUROBASIS CHINENSIS.

*Libellula chinensis*, *Linn. Syst. Nat.* i. p. 545 (1758).

Huldamura, June 10, 1892.

This species does not appear to be very common in Ceylon, though generally abundant throughout the East Indies.

## \*†46. VESTALIS APICALIS.

*Vestalis apicalis*, *Selys, Bull. Acad. Belg.* (2) xxxvi. p. 612 (1873); (2) xlvii. p. 362 (1879).

*Neurobasis apicalis*, *Kirb. Proc. Zool. Soc. Lond.* 1891, p. 204, pl. 20. figs. 2, 2a.

*Calopteryx* (*Vestalis*) *amœna*, *Hag. Verh. zool.-bot. Ges. Wien*, ix. p. 206 (1859), *nec Vestalis amœna*, *Selys*.

Kottawa, April 19 & 24, 1892.

Nawala-pittia (*Green*).

Col. Yerbury obtained several specimens of both sexes. The female is green, with the face mostly pale yellow in front, and the lateral sutures, underside of the thorax, and a lateral stripe on the basal segments of the abdomen of the same colour. Legs black, femora striped beneath with pale yellow. Wings of a slightly clouded hyaline, with black nervures. The three upper thoracic carinæ are black.

This female has much resemblance to that of *Neurobasis chinensis*; but the latter may be at once distinguished by the reticulated basal space, the green costal nervure, and generally the more clouded wings, with a false pterostigma.

\*†47. *PSEUDOPHÆA SPLENDENS*.

*Euphæa splendens*, *Selys, Syn. Calopt.* p. 52 (1853).

Kottawa, April 19, 1892.

Rambodde (*Hagen*).

*Female*. Black, two yellow spots on the vertex, a large one within each eye in front, separated by the antennæ from a smaller one, below which is a transverse yellow stripe, divided in two in the middle, just above the mandibles; prothorax with a yellow spot above on each side; mesothorax with two stripes on the back, below which in front are one or two small spots, followed by two broader stripes on the pleura; meso- and meta-thorax with many small yellow spots between the wings; abdomen with the 1st segment bordered behind with yellow; the segments with dorsal and lateral lines—the former narrowest, disappearing on the 5th segment, the latter continued to the 7th; 9th with a yellow spot on each side; front femora striped below with yellow; wings yellowish hyaline, with black nervures and pterostigma.

\*†48. *PSEUDOPHÆA CARISSIMA*, sp. n. (Pl. XLII. fig. 4, ♂.)

Long. corp. 40 millim.; exp. al. 50 millim.; long. pter. 3 millim.

*Male*. Inky black, two reddish-tawny appendages at the extremity of the 8th segment beneath. Wings not petiolated, with purple, violet, and green reflexions, semihyaline towards

the base, half as far as the nodus, but very slightly on the hind wings, and only towards the costa.

Upper appendages as long as the 10th segment, compressed, spatulate.

Kottawa, April 19, 24, 27, 1892.

Allied to *P. splendens*, but much smaller and differently coloured.

Var. *viridissima*.—Differs from the type in the fore wings, the extremity of the hind wings, and their costal area to the nodus being iridescent green with a slight coppery shade, and the hind wings, except at the extremity, the small hyaline patch at the base, and along the costal area to the nodus being of a brilliant green, as in *P. splendens*.

Kottawa, April 19, 1892.

As the only specimen of this form was taken at the same time and place as the others, which it much resembles, except in colour, I do not feel justified in regarding it as a distinct species.

\*49. MICROMERUS FINALIS.

*Micromerus finalis*, *Selys, Bull. Acad. Belg.* (2) xxvii. p. 665 (1869).

*Pundaloya (Green)*.

\*†50. MICROMERUS LINEATUS.

*Calopteryx lineata*, *Burm. Handb. Ent.* ii. p. 826 (1839).

Kanthalai, March 8, July 31, Aug. 8, 1892. Kottawa, April 24, 1892.

*Nawala-pittia (Green)*.

Also met with in India and Java.

CÆNAGRIONINÆ.

NORMOSTIGMATINÆ.

\*†51. COPERA MARGINIPES.

*Platycnemis marginipes*, *Ramb. Ins. Névr.* p. 240 (1842).

Hot Wells and other localities near Trincomali, July 4 & 17, 1890; Aug. 30, Sept. 27, Oct. 8 & 29, Nov. 22, 1891. Andankulam, Oct. 22, 1891. Hinaduma, April 28, 1892.

Many specimens, some taken *in coitu*. As was to be expected in the case of such delicate species, most of these were damaged. Previously recorded from Java, Malacca, and (probably) Japan.

52. *COPERA SERAPICA*.

*Psilocnemis serapica*, *Selys, Bull. Acad. Belg.* (2) xvi. p. 171 (1863).

*Trichocnemys serapica*, *Hagen, Verh. zool.-bot. Ges. Wien*, ix. p. 478 (1858).

Ceylon (*Nietner*).

Also met with in the Nicobar Islands.

\*†53. *PLATYSTICTA MACULATA*.

*Platysticta maculata*, *Selys, Bull. Acad. Belg.* (2) x. p. 437 (1860).

*Platysticta Greeni*, *Kirb. Proc. Zool. Soc. Lond.* 1891, p. 204, pl. 20. figs. 3, 3 a.

Haycock Hill, April 27, 1892.

Rambodde (*Nietner*); Pundaloya (*Green*).

On carefully comparing the descriptions again, I have come to the conclusion that my *P. Greeni* is probably identical with *P. maculata*, De Selys.

\*†54. *PLATYSTICTA APICALIS*, sp. n. (Pl. XLII. fig. 1, ♂.)

Long. corp. 57–61 millim. (♂), 51 millim. (♀).

*Male*. Steel-blue; rhinarium, nasus, prothorax (except the hind border above, under surface of thorax, and a lateral stripe), coxæ, trochanters, and base of femora all yellow, legs otherwise black; sides and under surface of abdomen beneath mostly yellow (or in the female tawny), except towards the extremity; segments 9 and 10 blue above in male.

Wings hyaline, with blackish nervures; apex, as far as the inner edge of the pterostigma, smoky brown in male, yellowish in female; pterostigma longer than broad, large, lozenge-shaped, dark brown, covering one cell (exceptionally two). Subnodal sector broken, median sector rising before the vein descending from the nodus; sectors of the arcus rising close together from a very short stalk; 19–21 postcubital nervures.

Upper anal appendages of male black, more than twice as long as the 10th segment, curved up and then downwards, and dilated at each extremity; lower appendage more slender, shorter, with an erect point at its base and a notch before its upturned point.

In the female the terminal segments of the abdomen are not blue, but there is a small yellow mark on each side of the 9th, and one on the back of the 10th, in the middle. Anal appendages strong, pointed, as long as the 10th segment.

Belihul-Oya, June 6, 1892.

Described from three specimens, two males and a female. It is a stouter insect than *P. maculata*, to which it is closely allied, and the dark apical patch is very characteristic.

\*†55. *PLATYSTICTA TROPICA*.

*Platysticta tropica*, *Selys, Bull. Acad. Belg.* (2) x. p. 438 (1860).  
Passara, June 6, 1892. Haycock Hill, July 27, 1892.

56. ? *PLATYSTICTA MONTANA*.

*Platysticta montana*, *Selys, Bull. Acad. Belg.* (2) x. p. 438.  
Described from Ceylon.

There is a single male in Col. Yerbury's collection, which I refer with some doubt to this species, as it has only twelve post-nodal cross-nervures.

57. *PLATYSTICTA HILARIS*.

*Platysticta hilaris*, *Selys, Bull. Acad. Belg.* (2) x. p. 438 (1860).  
Rambodde (*Hagen*).

\*58. *PLATYSTICTA DIGNA*.

*Platysticta digna*, *Selys, Bull. Acad. Belg.* (2) x. p. 440 (1860).  
Described from Ceylon.

\*†59. *DISPARONEURA CÆSIA*.

*Alloneura cæsia*, *Selys, Bull. Acad. Belg.* (2) x. p. 450 (1860).  
Galbodde, May 24, 1892.  
Pundaloya (*Green*).

60. *DISPARONEURA CENTRALIS*.

*Alloneura centralis*, *Selys, Bull. Acad. Belg.* (2) x. p. 449 (1860).  
Rambodde (*Nietner*).

\*†61. *DISPARONEURA TENAX*. (Pl. XLI. fig. 2, ♂.)

*Alloneura tenax*, *Selys, Bull. Acad. Belg.* (2) x. p. 449 (1860).  
Passara, June 6, 1892.  
Rambodde (*Hagen*).

\*†62. *DISPARONEURA OCULATA*, sp. n.

Long. corp. 40 millim.; exp. al. 42 millim.; long. pter. 1 millim.

*Female*. Black with pale yellow markings above, pale yellow below. Head black, with a very broad band running from eye to eye above the epistoma, where it is somewhat narrowed in the middle; prothorax and mesothorax black above, with two yellow lines, narrowest behind; sides yellow, with a black lateral line on

the principal suture, narrow and interrupted in front and broader behind; abdomen very slender, black, yellowish beneath in front, and with a lateral yellowish line as far as the 6th segment; femora tawny, tibiæ whitish, knees and tarsi blackish; wings hyaline, with blackish nervures; pterostigma black, thick, covering a little more than one cell; 16 postnodal nervures.

Anal appendages black, pointed, as long as the 8th segment.

Kottawa, April 24, 1892.

Differs from *D. tenax* and allies by the two conspicuous yellow spots on the vertex between the eyes.

\*†63. *DISPARONEURA SITA*, sp. n.

*Male* (probably young). Head black above and behind, whitish in front and behind; epistoma narrowly edged with black in front, a narrow whitish stripe on the vertex, interrupted by a black dot in the middle; thorax bronzy black, with two whitish dorsal lines and broader lateral stripes; abdomen bronzy brown, with a narrow whitish ring at the base of segments 2-5; segments 2 and 3 with a very narrow dorsal whitish line, and 2 with a lateral yellowish line, angulated upwards towards the extremity, where it meets on the back; the tips of segments 2-5 blackish; 6 with the terminal third rufous; 7-10 black; anal appendages short, whitish, the lower appendages longer than the upper; wings hyaline, with blackish nervures; 12-14 postnodal cross-nervures on fore wings; pterostigma blackish, lozenge-shaped, surrounded by a pale line; upper sector of the triangle on the fore wings extending one or two cells beyond the vein of the nodus; second sector of the triangle forming a very small isolated cell, rising just before the basal postcostal nervure, and only extending about one-third of the distance from this to the next; legs whitish, lined with black; tarsi black.

A more adult specimen is nearly black, with the stripe on the vertex and the narrow dorsal lines on the thorax bluish, nearly obsolete.

Hot Wells, Trincomali, Oct. 23, 1890; Sept. 6 & 13, 1891.

Probably allied to *D. interrupta*, De Selys, from Singapore.

\*†64. *ONYCHARGIA ATROCYANA*.

*Argia atrocyana*, Selys, *Bull. Acad. Belg.* (2) xx. p. 416 (1865).

Udagama, April 30, 1892.

Previously recorded from Singapore and Java.

## \*†65. MICRONYMPHA SENEGALENSIS.

*Agrion senegalensis*, *Ramb. Ins. Névr.* p. 276 (1842).

Hot Wells, Trincomali, Nov. 11, 1891.

A common species throughout Africa and the East Indies.

## \*†66. MICRONYMPHA AURORA.

*Agrion* (*Ischnura*) *aurora*, *Brauer, Verh. zool.-bot. Ges. Wien*, xv. p. 509 (1855).

*Ischnura delicata*, *Selys, Bull. Acad. Belg.* (2) xlii. p. 990 (1870).

Trincomali and neighbourhood, Sept. 13, 16, 27, Oct. 6, Nov. 23, Dec. 29, 1891. Mahagany, Dec. 20, 1891. Velry, Oct. 25, 1891. Andankulam, Oct. 7, 1891. Pusara, June 6, 1892. Bandarawella, June 7, 1892.

Rambodde (*Hagen*); Pundaloya (*Green*).

Common throughout the East Indies; also found in Australia and Tahiti.

## \*†67. CERIAGRION CERINORUBELLUM.

*Agrion* (*Pyrhosoma*) *cerinorubellum*, *Brauer, Verh. zool.-bot. Ges. Wien*, xx. p. 511 (1865).

Mahagany, Sept. 20, 1891. Trincomali and Hot Wells, Sept. 13, 27, Oct. 3, 6, 1891. Henaratgoda, Feb. 7, 1892.

A common East-Indian species.

## \*†68. CERIAGRION COROMANDELIANUM.

*Agrion coromandelianum*, *Fabr. Ent. Syst. Suppl.* p. 287 (1798).

Trincomali, Oct. 12, 1890; Oct. 3, Nov. 24, 1891; Jan. 6, 1892.

Rambodde (*Hagen*).

Also met with in India.

## \*†69. ARCHIBASIS CEYLANICA.

*Archibasis ceylanica*, *Kirb. Proc. Zool. Soc. Lond.* 1881, p. 255, pl. 20. fig. 4.

Hot Wells, Trincomali, Sept. 13, 1891.

Kandy (*Green*).

## 70. AGRIOCNEMIS PYGMÆA.

*Agrion pygmæum*, *Ramb. Ins. Névr.* p. 278 (1842).

Noted by Baron de Selys Longchamps as found in Ceylon.

An Indian species.

## 71. AGRIOCNEMIS VELARIS.

*Agriocnemis velaris*, *Selys, An. Soc. Esp.* xi. p. 31 (1882).



*Agrion velare*, *Hag. Verh. zool.-bot. Ges. Wien*, viii. p. 479 (1858).

*Agriocnemis pygmæa*, *Selys, Bull. Acad. Belg.* (2) xliii. p. 146 (1877).

Rambodde (*Hagen*).

Also occurs in the Philippines.

\*†72. *LESTES ELATUS*.

*Lestes elata*, *Selys, Bull. Acad. Belg.* (2) xiii. p. 318 (1862).

Trincomali and neighbourhood, Jan. 4, Oct. 3, 25, 30, Nov. 24, 1891.

Rambodde (*Hagen*); Pundaloya (*Green*).

This species varies much, but may always be distinguished by the two broad green bands on the back of the thorax, which are securiform behind, and below which three black or green spots in an oblique series are always visible. In the less adult specimens the pterostigma is yellow, and the abdomen is yellowish towards the extremity and on the sides. In the most adult specimens the pterostigma is blackish, and the abdomen is almost entirely bronzy black above, even the anal appendages being blackish. The postnodal cross-nervures vary from 10 to 13.

\*†73. *LESTES DECIPIENS*, sp. n.

Long. corp. 35 millim.; exp. al. 40 millim.; long. pter.  $1\frac{1}{2}$  millim.

*Male*. Pulverulent above, yellowish below; head blackish above; orbits sometimes yellowish, labrum sometimes greenish; prothorax with green spots in the middle above and with black ones on the sides; mesothorax pulverulent bluish-grey, with two broad dorsal tripartite green stripes, separated by a pulverulent or yellowish stripe; sides with some blackish spots, and sometimes with traces of two obsolete blackish bands; abdomen black, pulverulent above, and yellowish below except at the extremity; segments 1 and 2 yellowish on the sides, the remaining segments with a narrow ring at the base and another at the extremity, before which the yellowish colour runs upwards triangularly on the sides; on the 7th segment the basal band, and on the 9th segment the terminal band is much broader; last three segments black, with yellow spots on the sides; anal appendages yellowish, black at the base and tip, as long as the 9th segment, with a small tooth on each side on the inside of the base, then somewhat flattened and depressed, the tips angulated downwards and curving inwards; lower appendages short, black.

Legs yellow, lined with black, and set with rather long hairs.

Wings clear hyaline; pterostigma blackish, about twice as long as broad, covering two cells; 9-12 postnodal cross-nervures.

Female very similar, but yellowish where the male is pulverulent; anal appendages as long as the 10th segment, yellowish. Immature specimens are almost entirely yellowish, with only the outline of the tripartite bands, &c., indicated, and the pterostigma yellowish.

Nilavelli, Nov. 16, 1890. 6th Milestone, Nilavelli Road, Dec. 9, 1891. Mahagany, Sept. 20, Dec. 20, 1891. Kandy, May 19, 1892.

Allied to *L. præmorsa* (Philippines) and *L. quercifolia*, De Selys (Menado and Sulu), but apparently distinct.

It is to be regretted that Col. Yerbury obtained no specimens of the second section of *Lestes*, with narrow pointed triangles, of which several imperfectly-known species occur in Ceylon.

#### 74. *LESTES ORIENTALIS*.

*Lestes orientalis*, Selys, *Bull. Acad. Belg.* (2) xiii. p. 322 (1862).

Rambodde (*Nietner*).

#### 75. *LESTES GRACILIS*.

*Lestes gracilis*, Selys, *Bull. Acad. Belg.* (2) xiii. p. 327 (1862).

Rambodde (*Nietner*); Pundaloya (*eadem*?) (*Green*).

#### 76. *LESTES DIVISUS*.

*Lestes divisa*, Selys, *Bull. Acad. Belg.* (2) xiii. p. 328 (1862).

Rambodde (*Nietner*).

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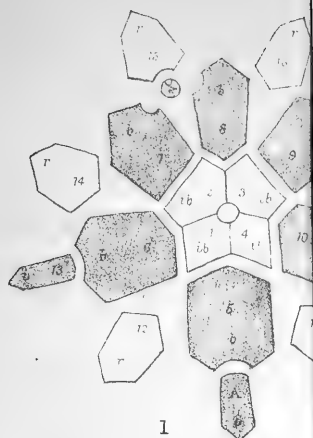
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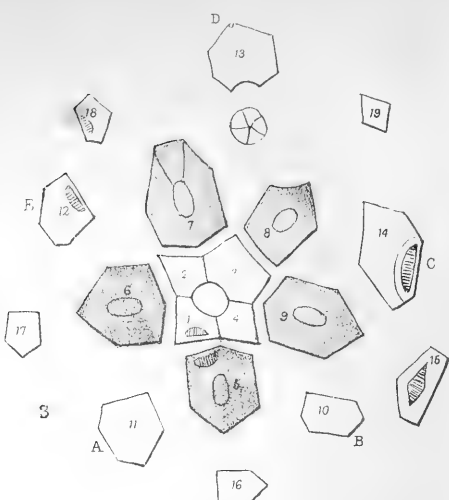
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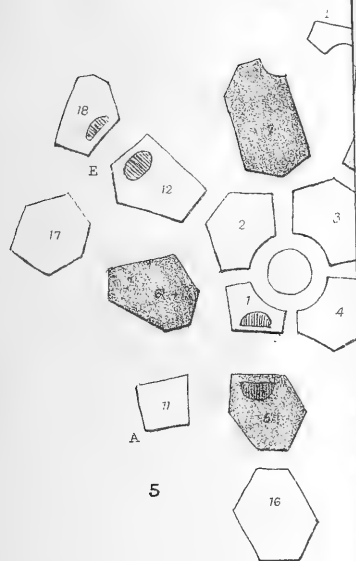
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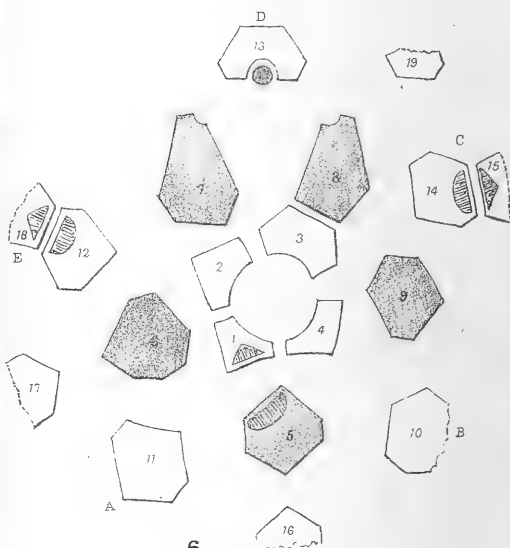
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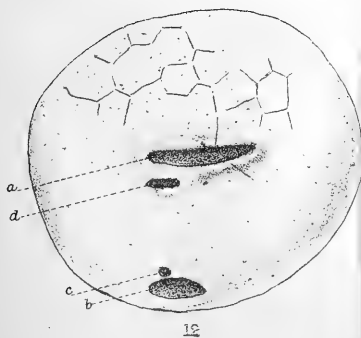
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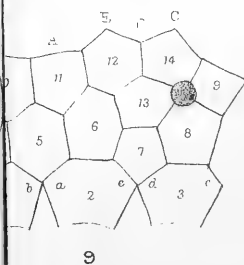
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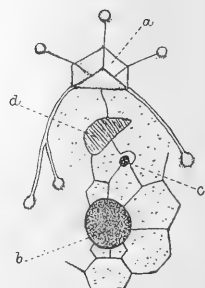
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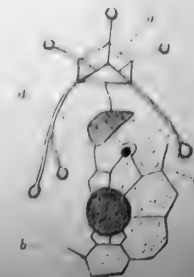
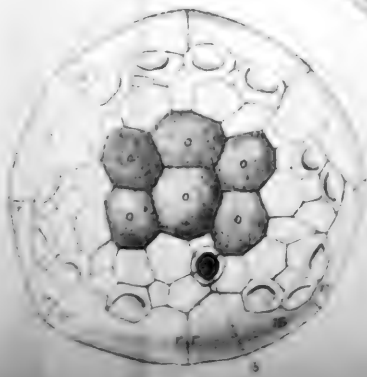
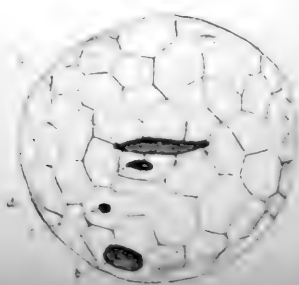
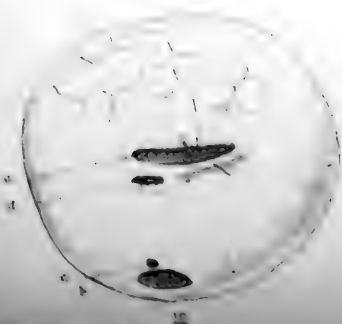
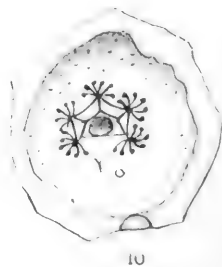
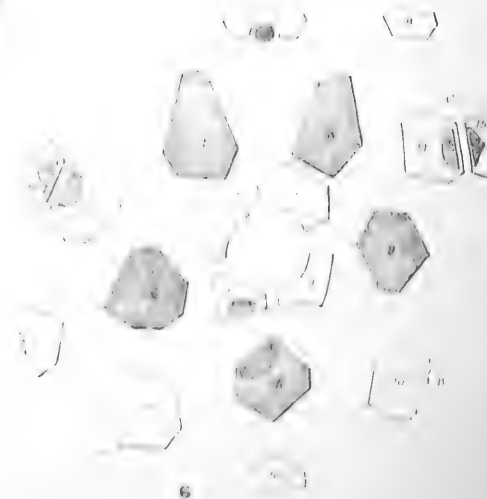
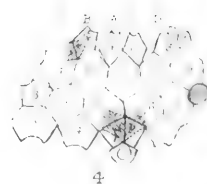
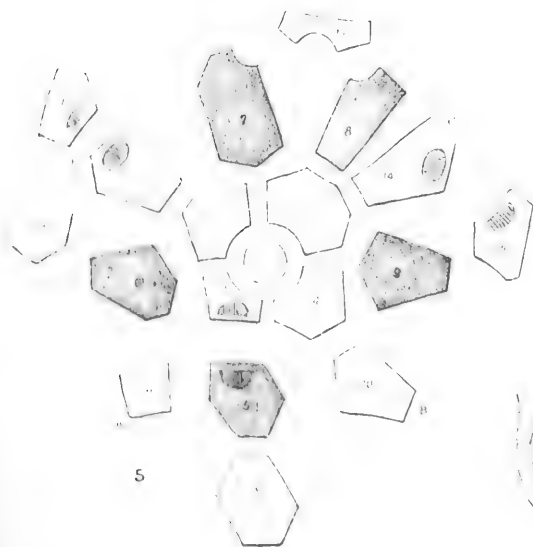
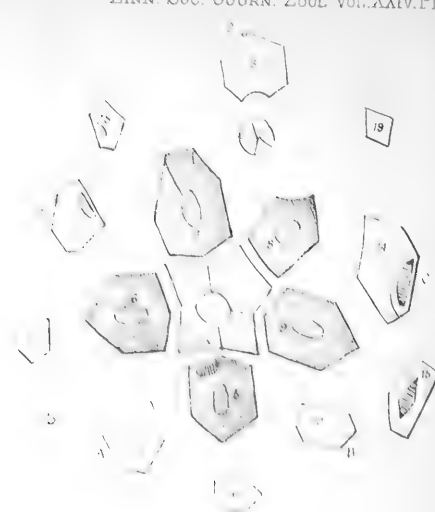
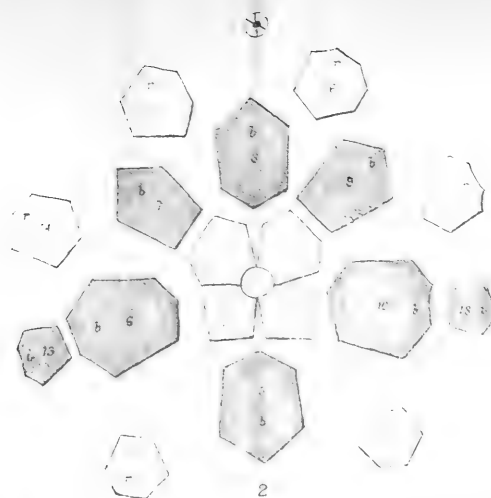
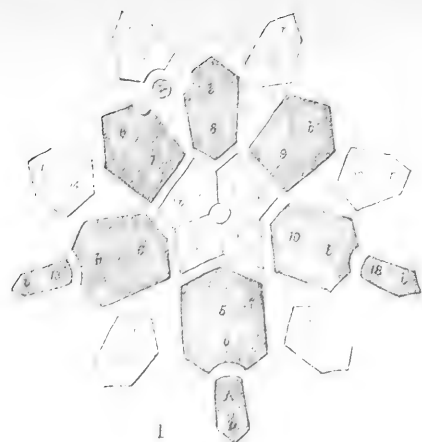


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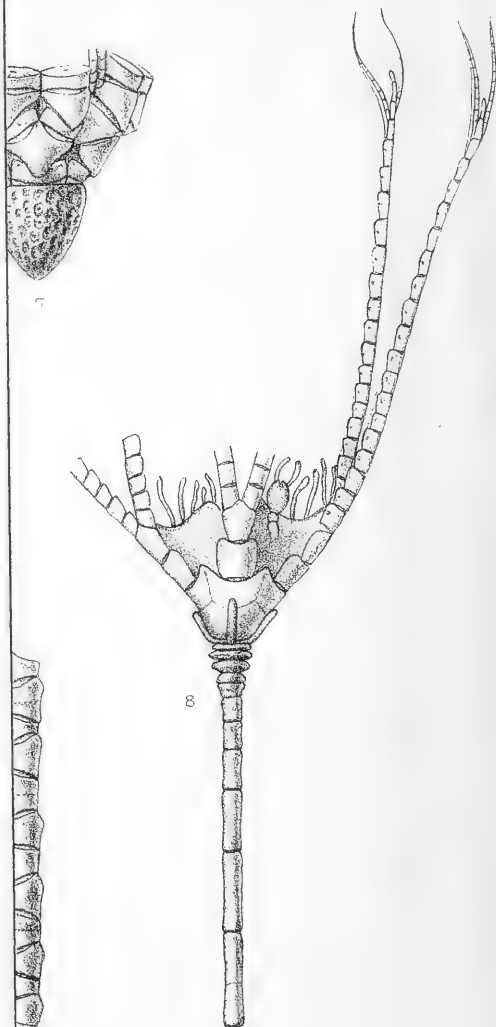
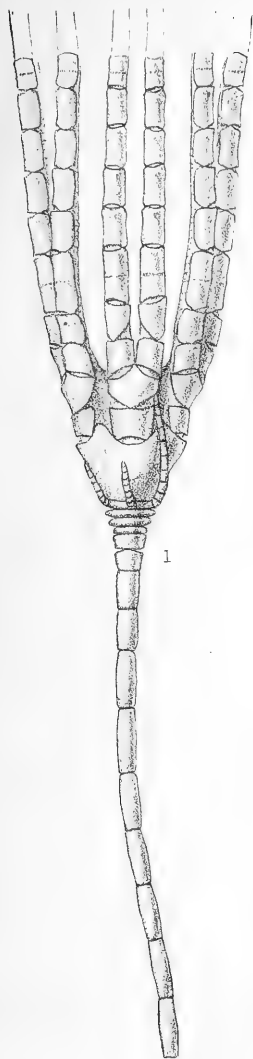




Barrois & Hylleberg del et lith

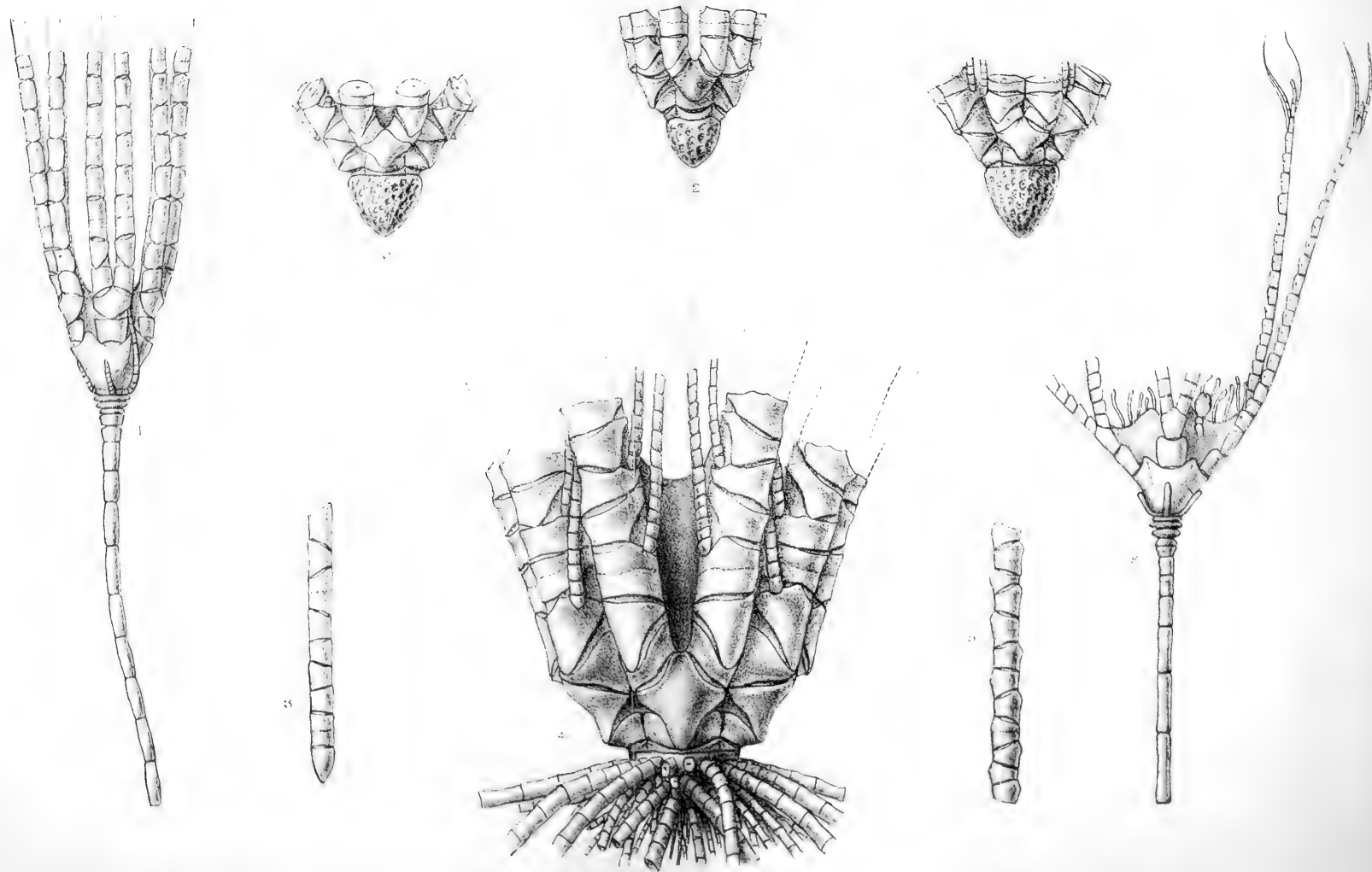
West, Newman, imp











Boysen & Highley del et lith

ARCTIC COMATULÆ

*Urticina* sp.





Mintern del.

Mintern Bros. lith.

GENITALIA OF HERMAPHRODITE FISHES.  
1. SALMO FARIO. 2. SCOMBER SCOMBER.

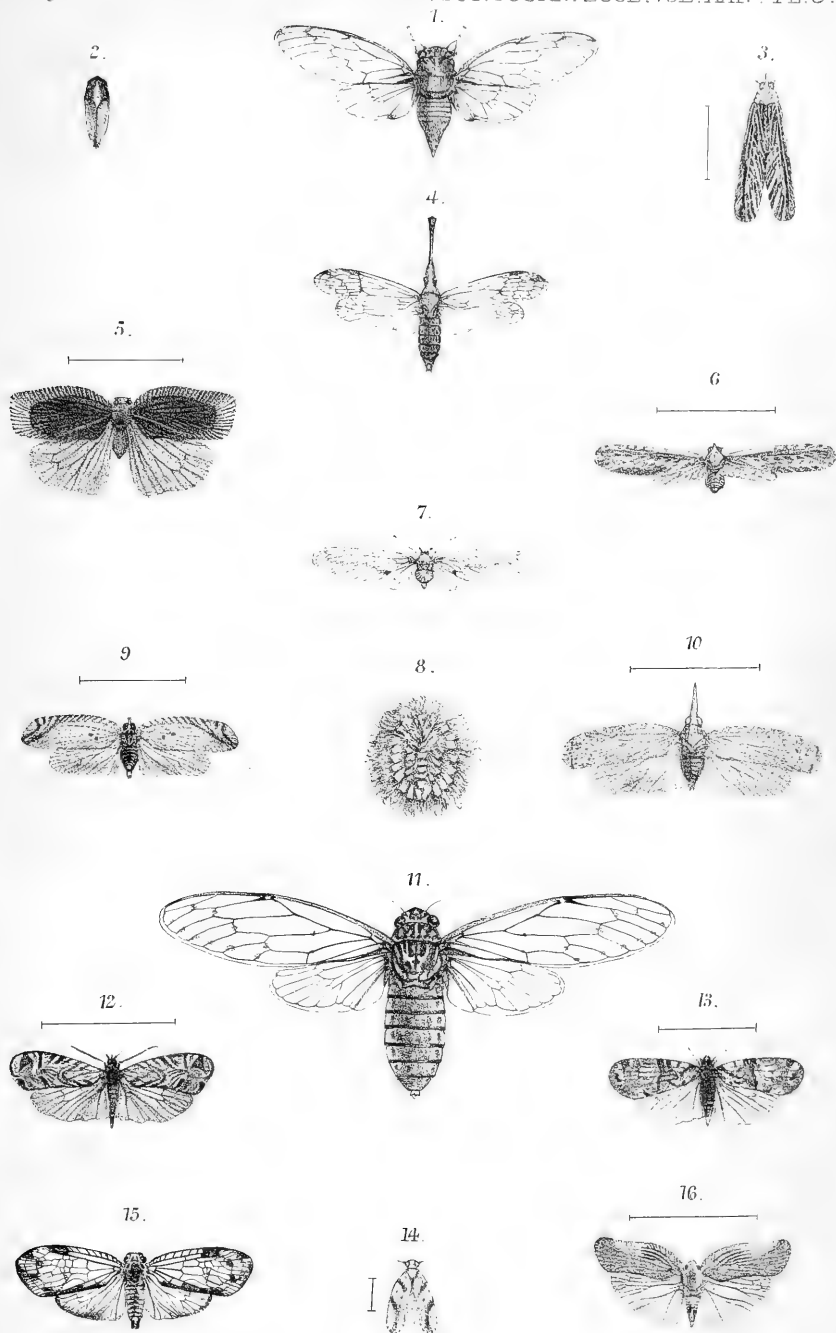




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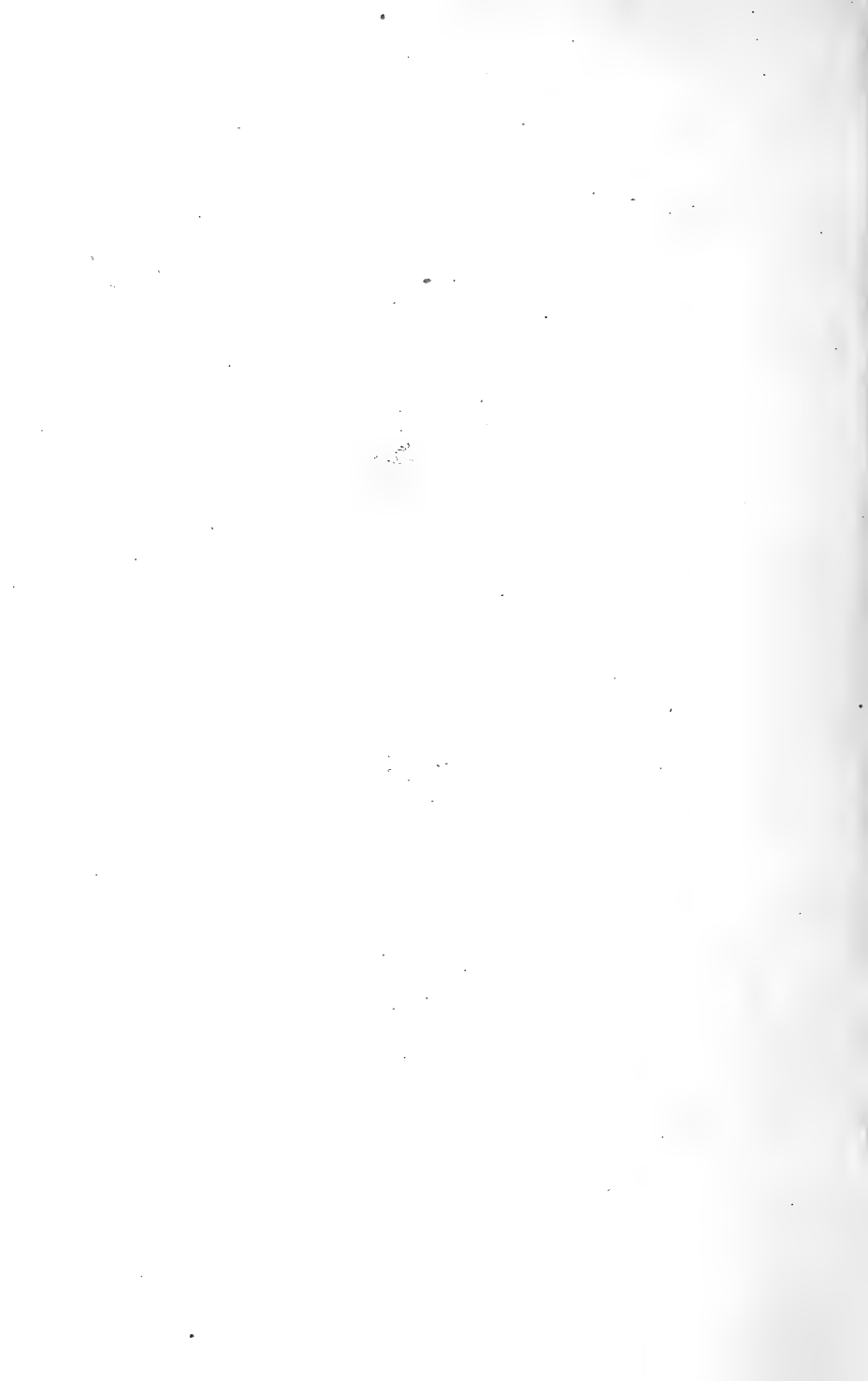


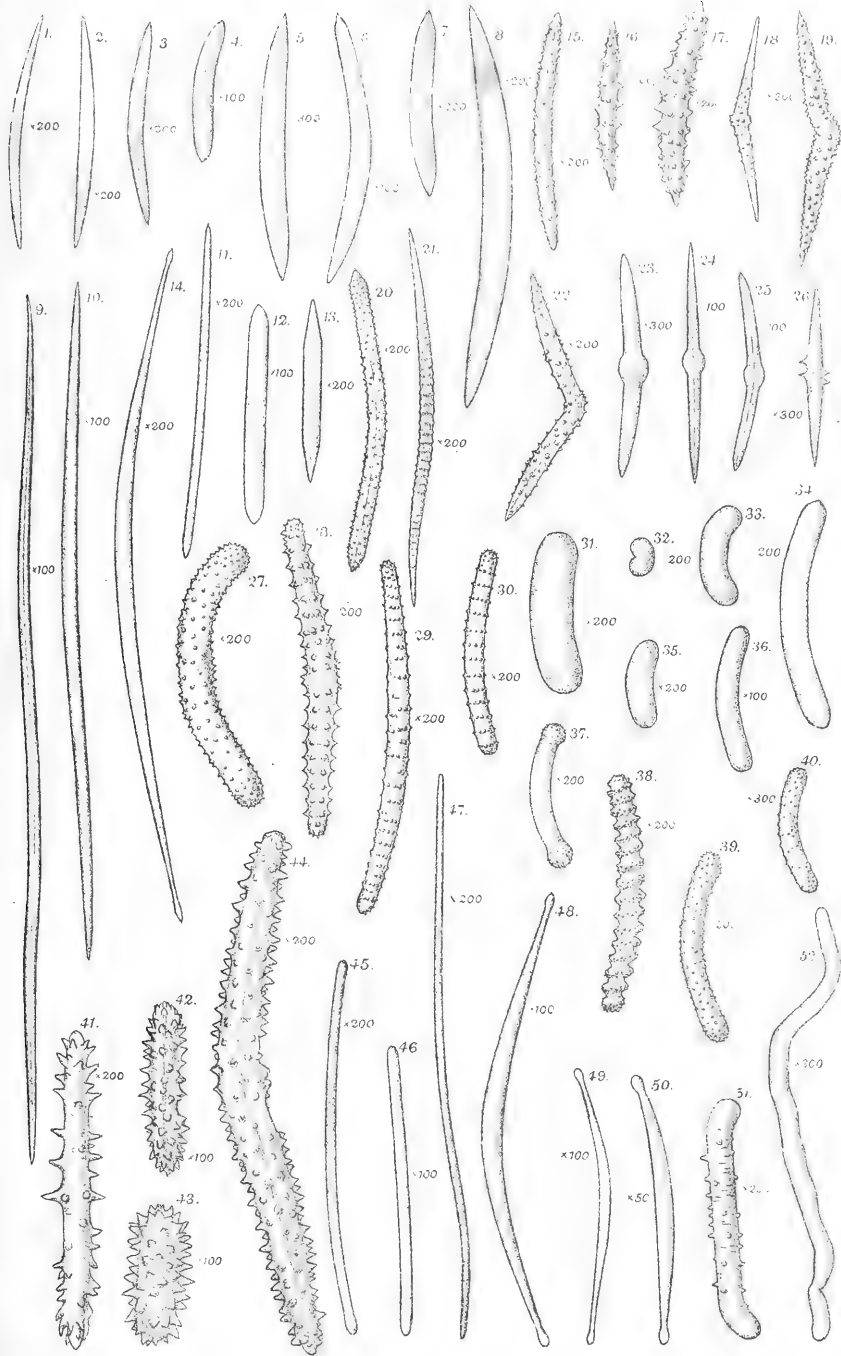




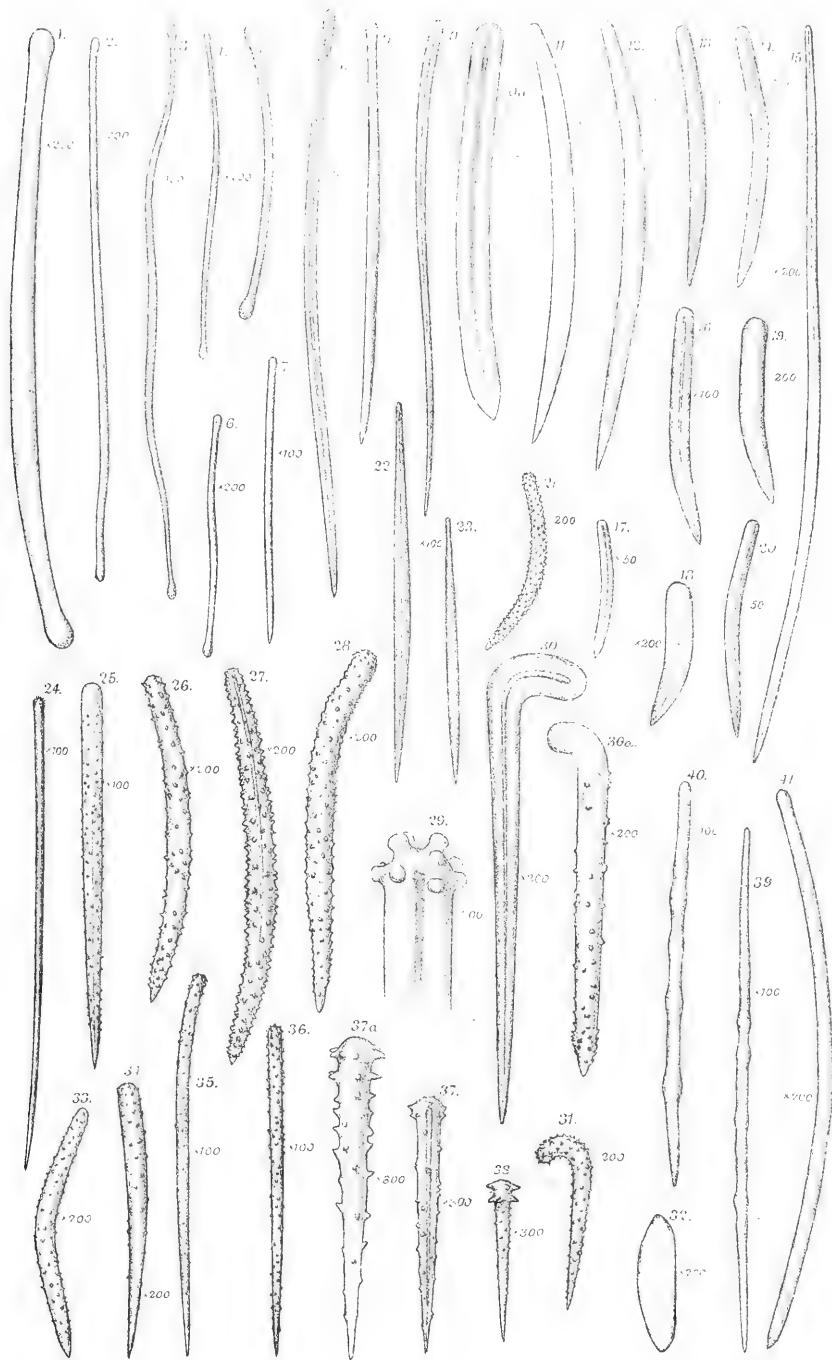
Michael del. et lith.

Mintern, Chromo lith.

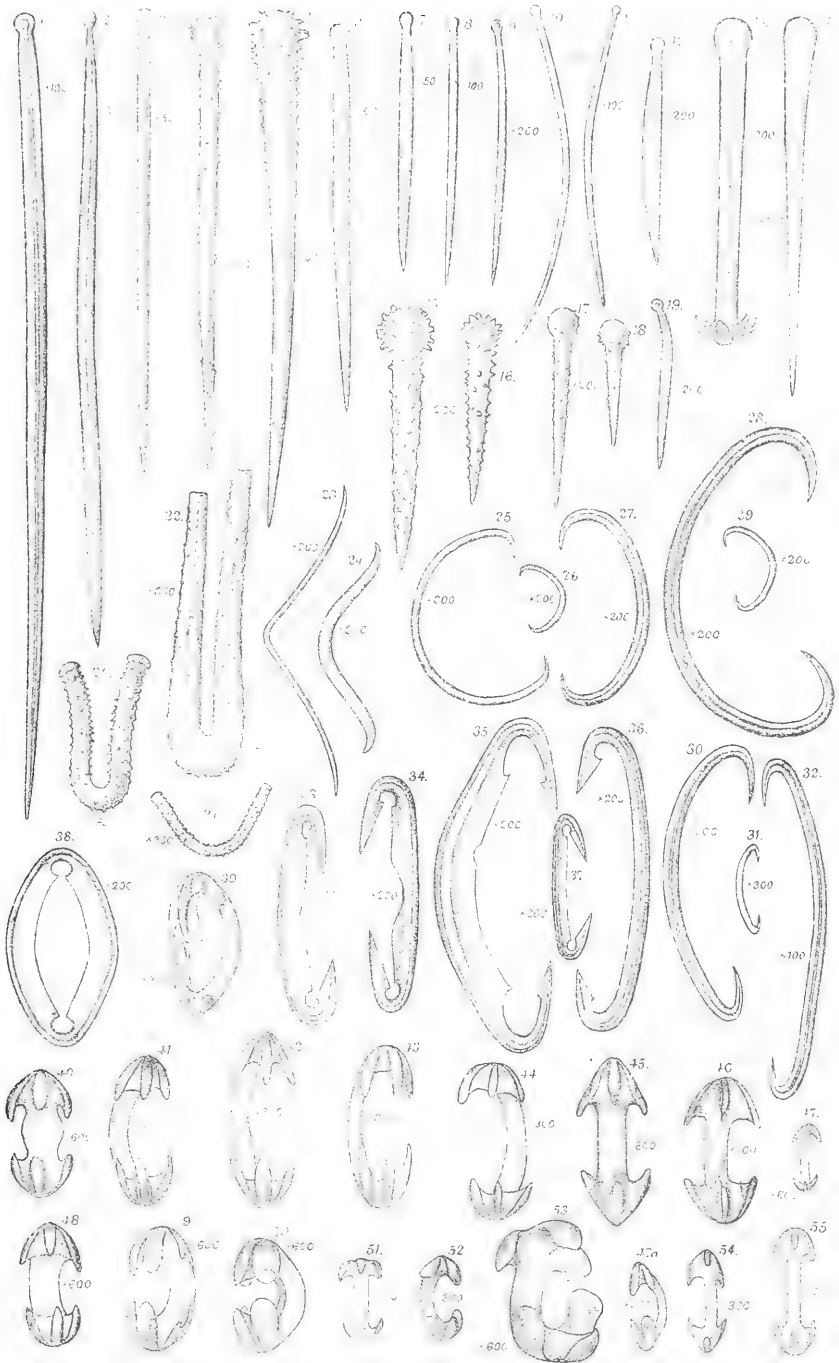










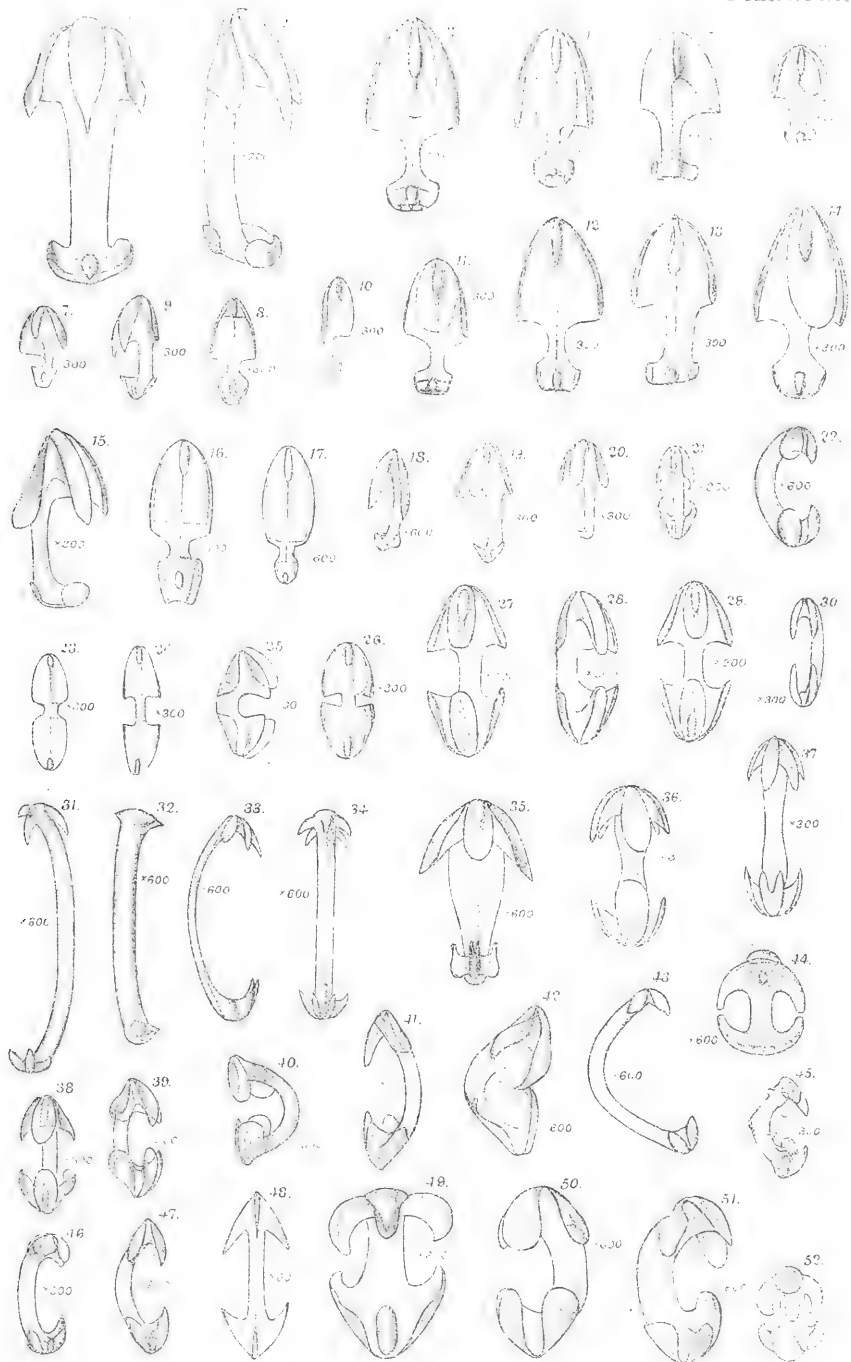


G.J Hinde del.  
A.T.Hollick lith.

West, Newman, imp.



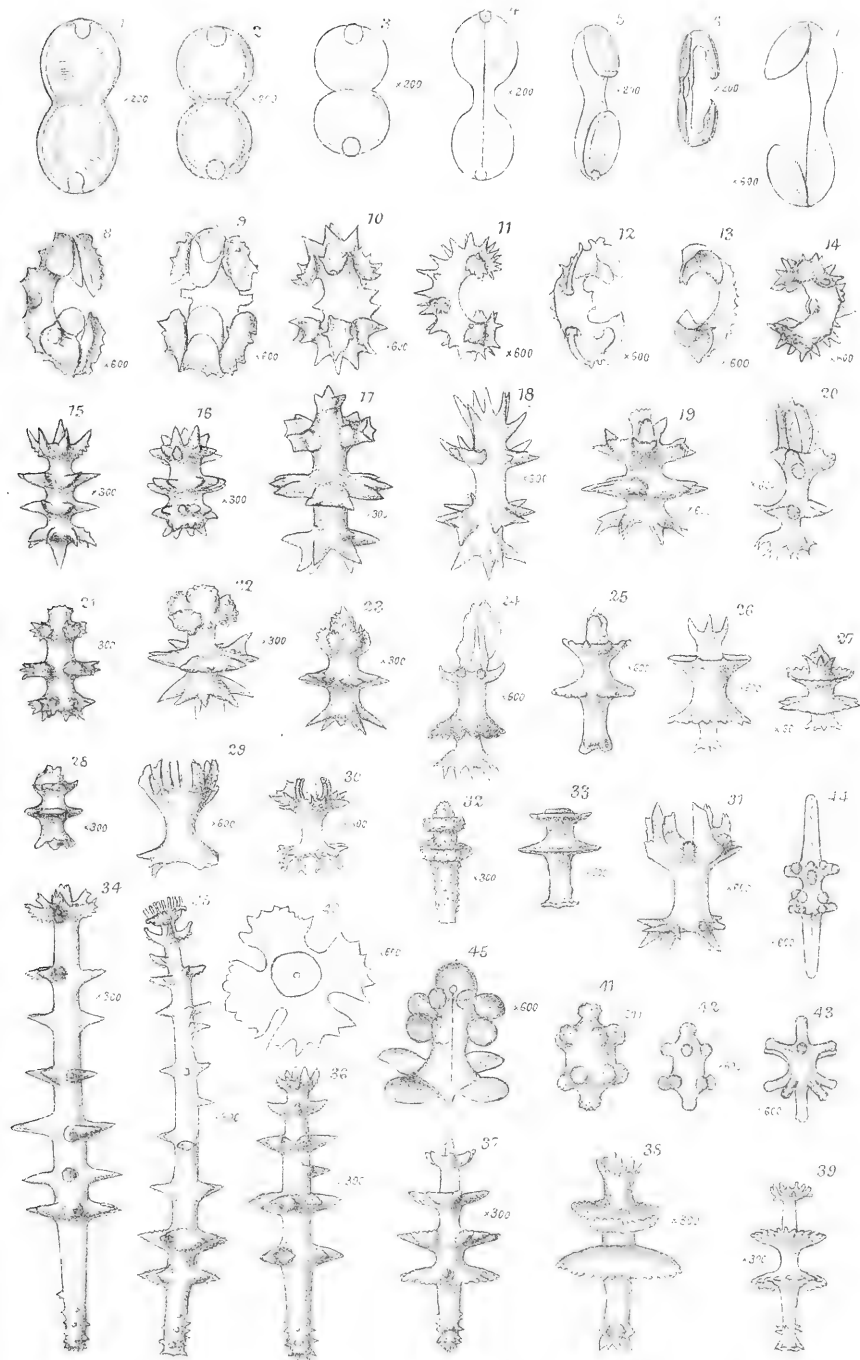




G. J. Hinde del.  
A. T. Höllick lith.

West, Newman, imp.

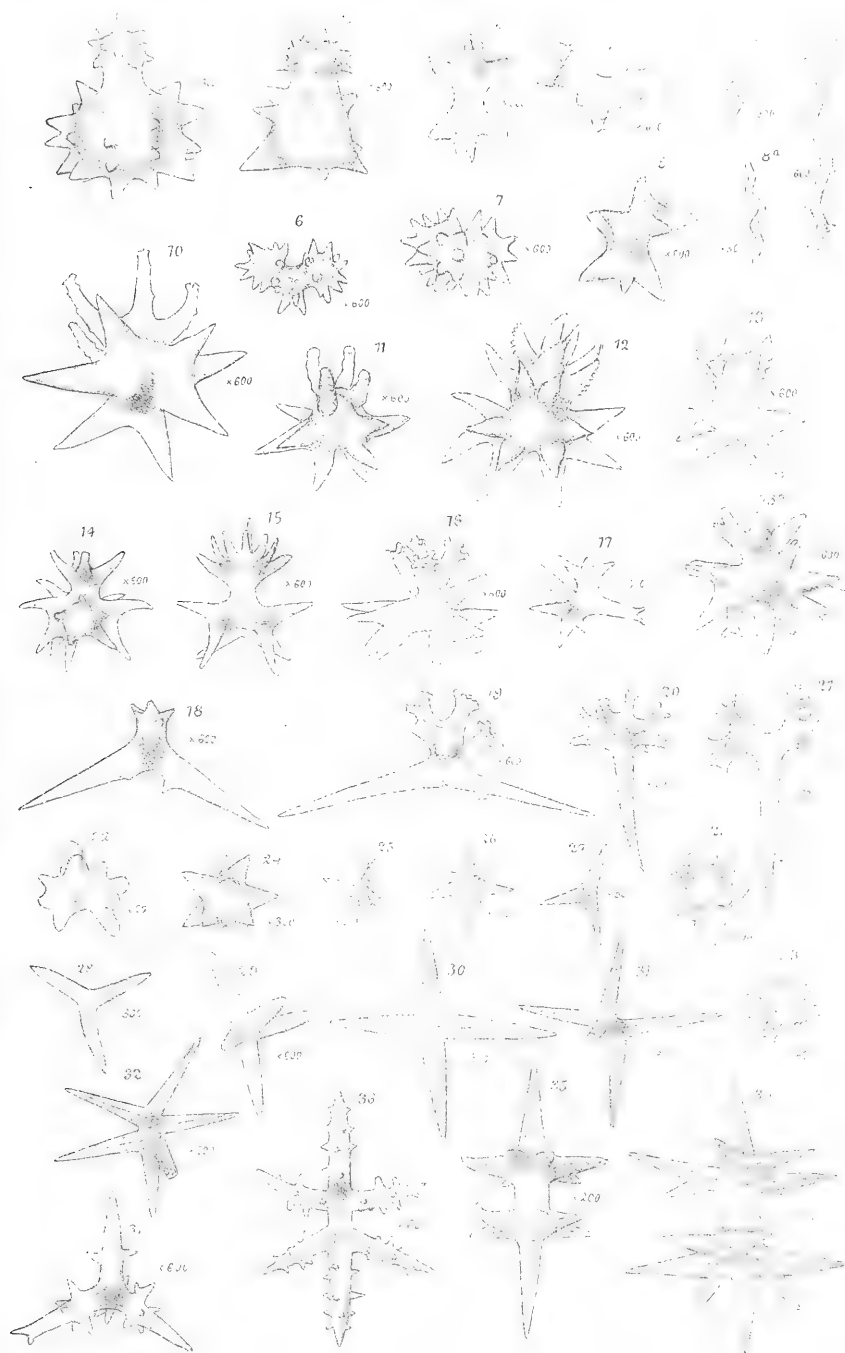




G.J.Hinde del.  
A.Hollick lith.

West, Newman imp.





G.J. Hinde del.  
A.T. Hollister lith.

West, Newman imp.



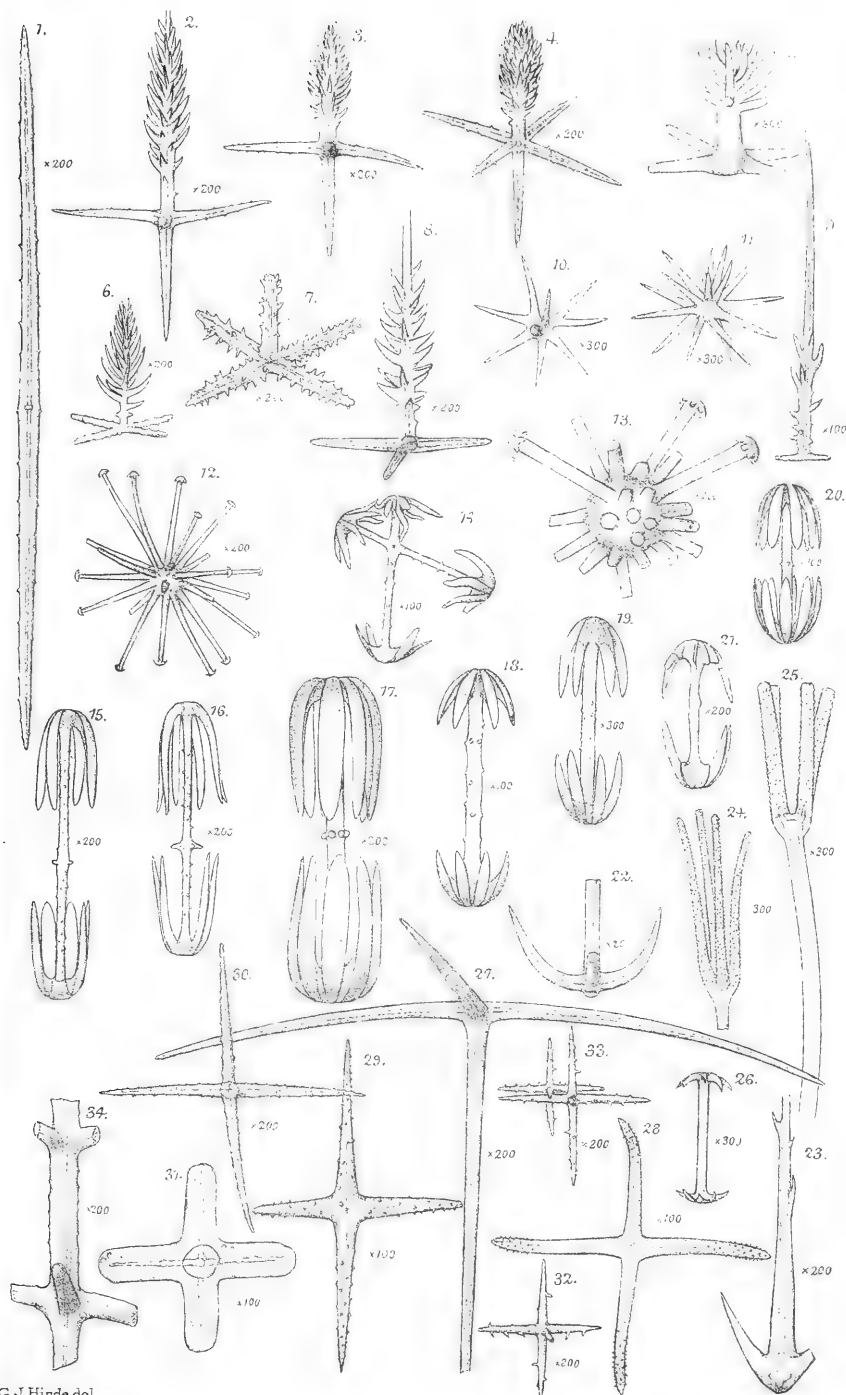








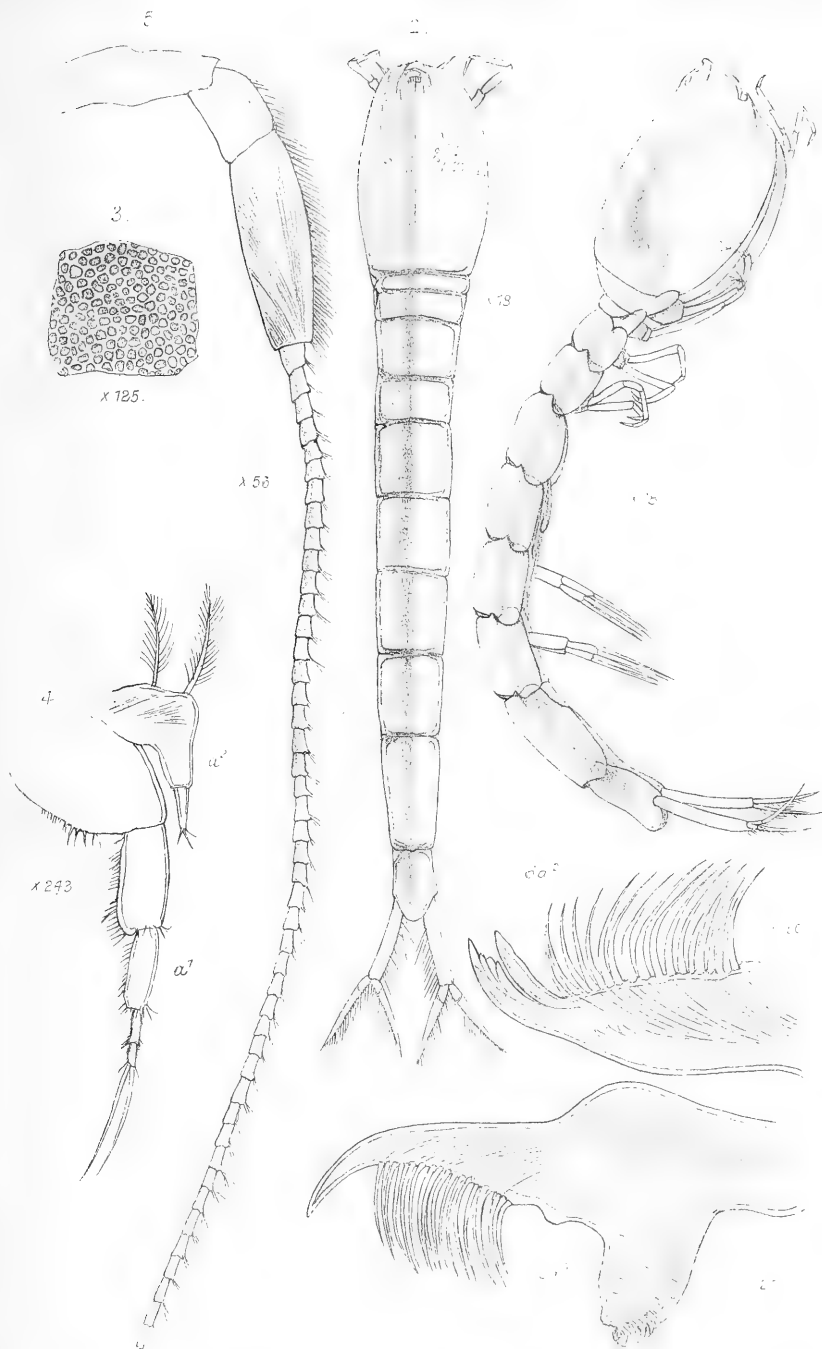


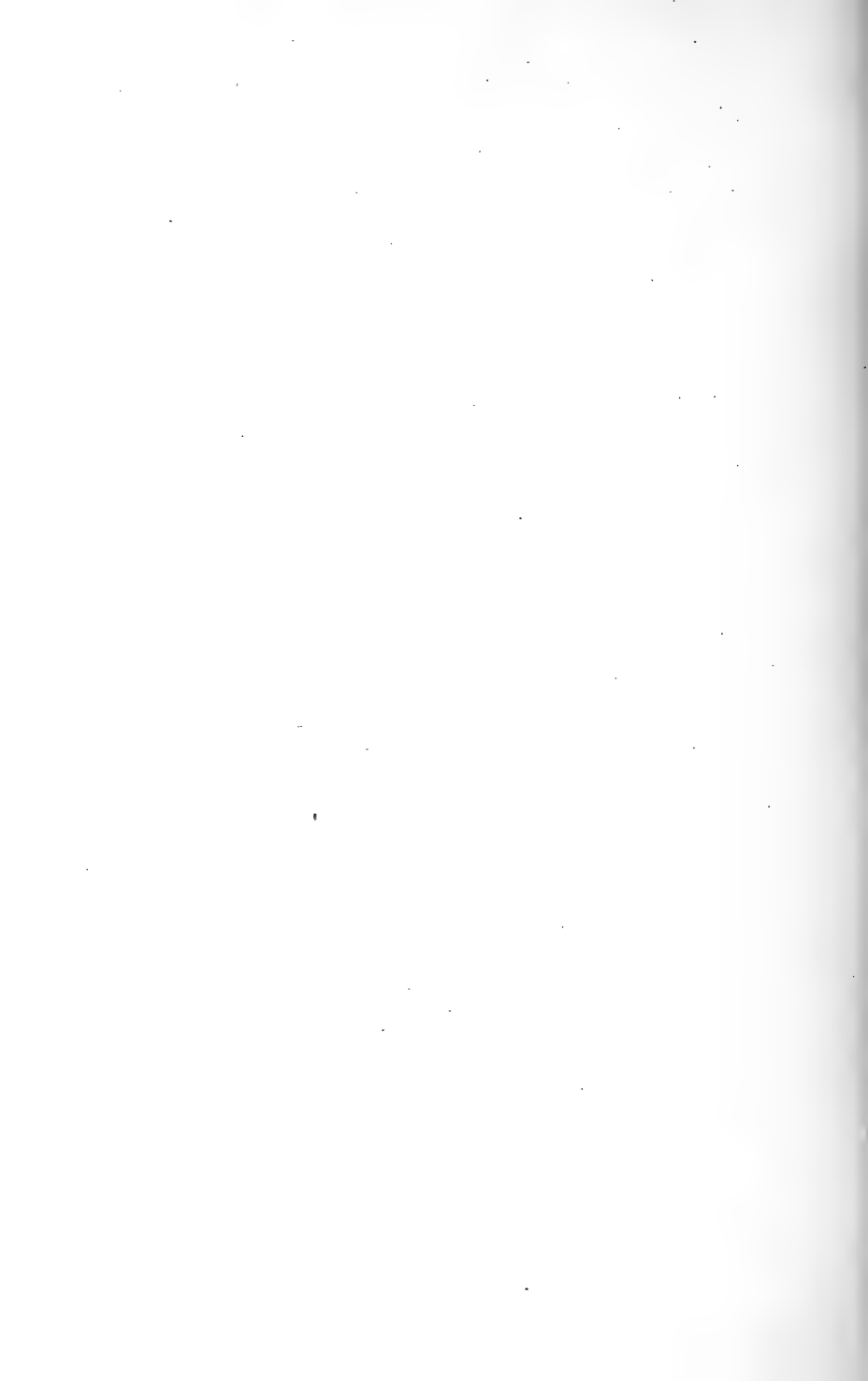


G.J. Hinde del.  
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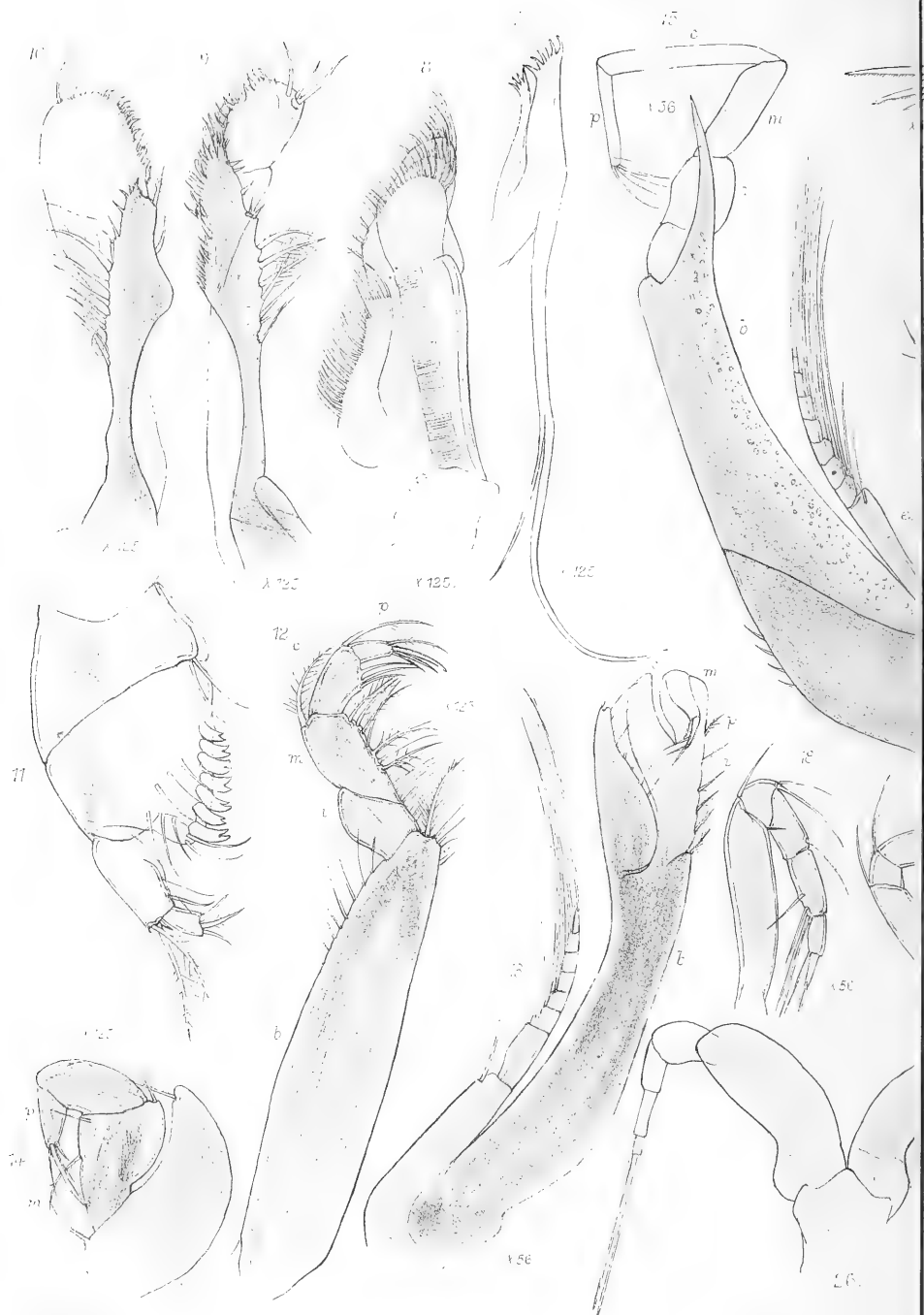
West, Newman imp.





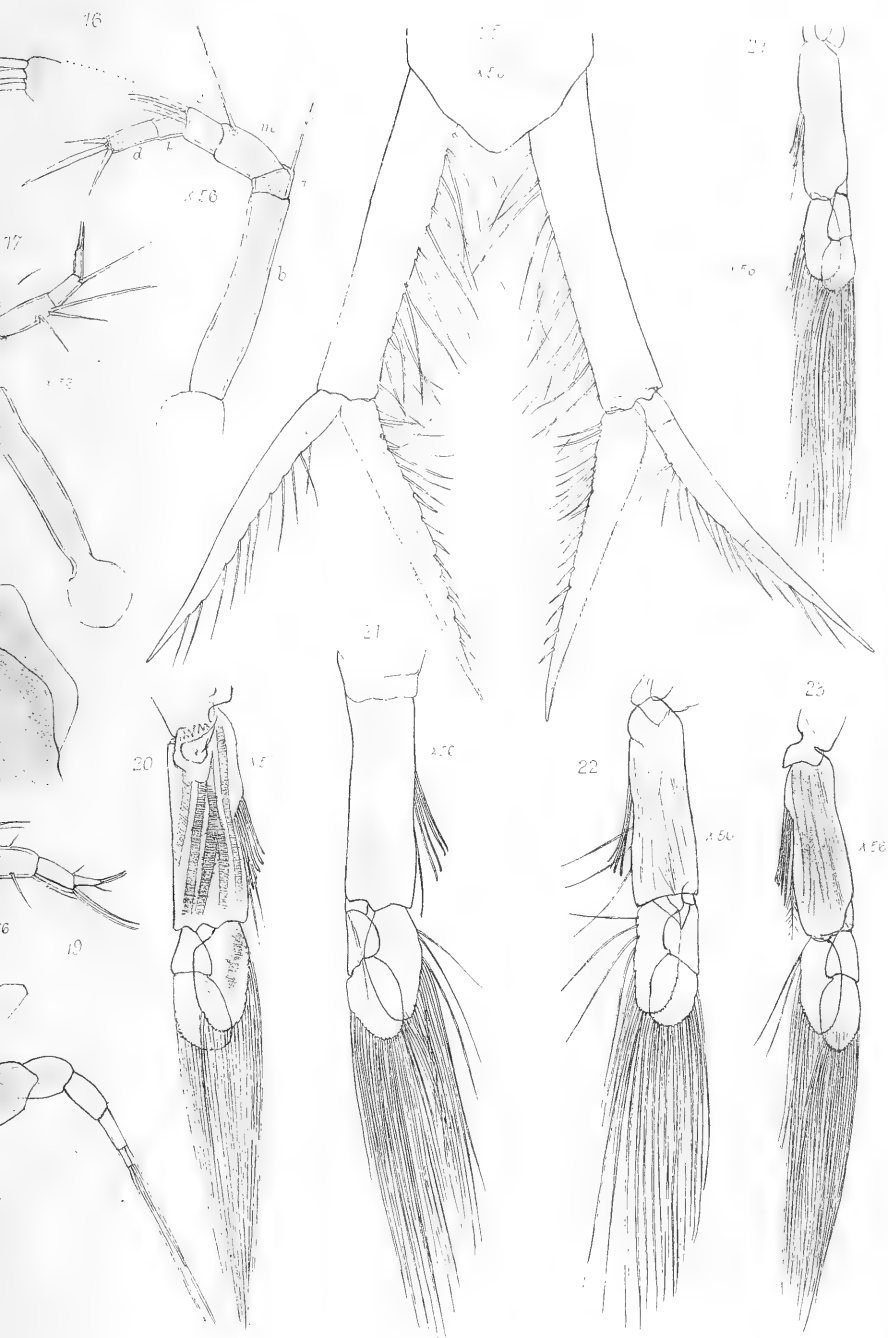






F.H. Michael Ltd





Mintern Bros. imp.





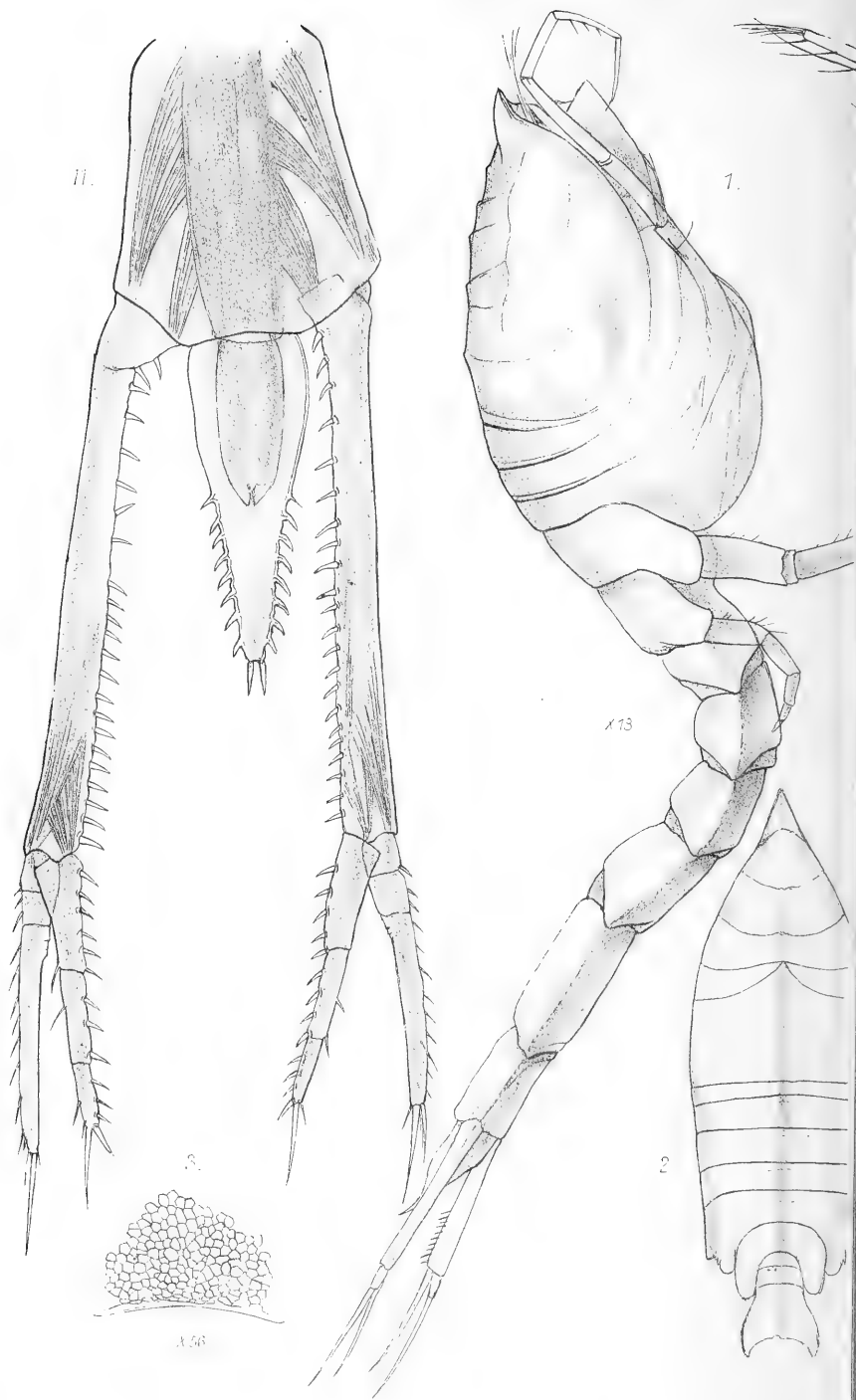
by W. Thomson, Esq.  
 & H. Michael, Esq.

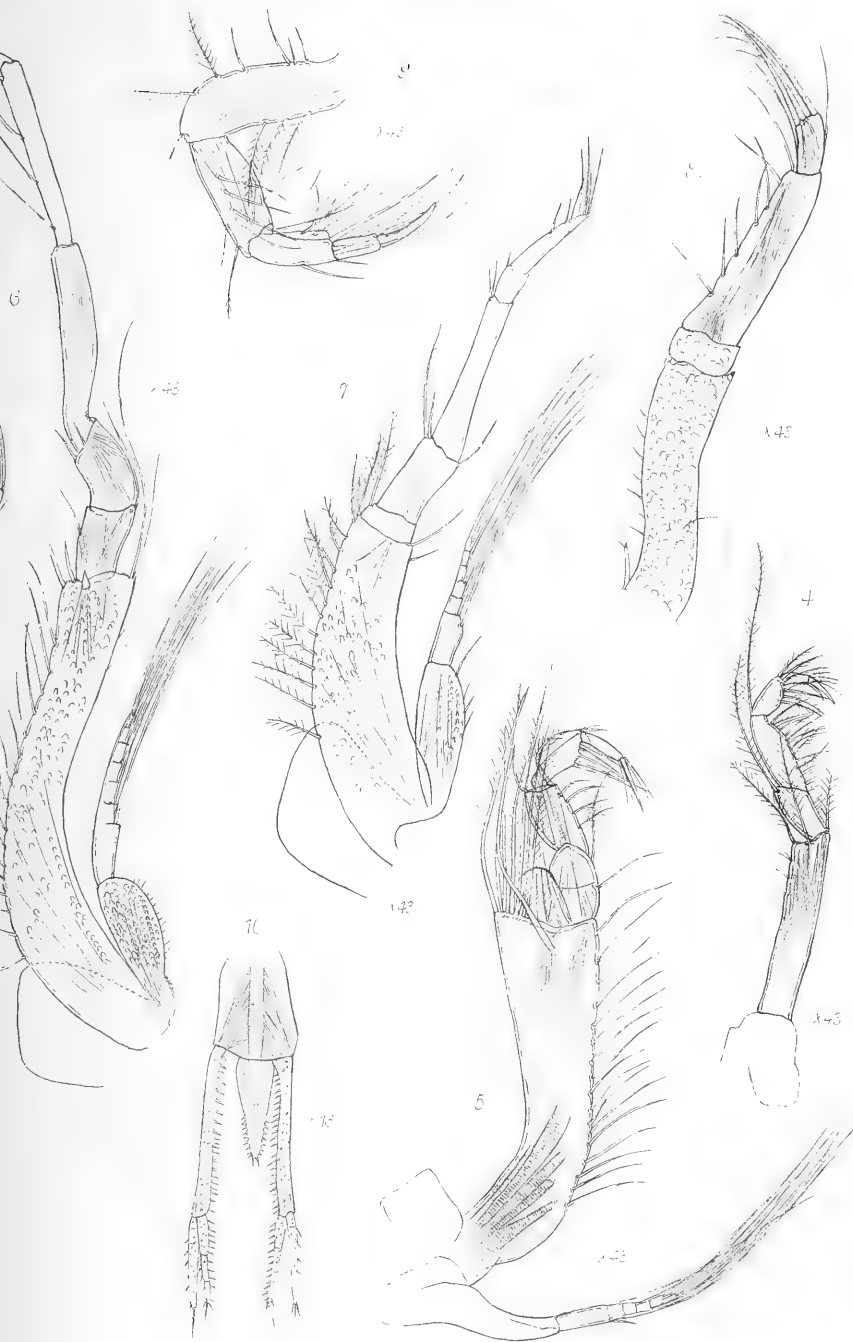
NEW SPECIES OF CUMACIA FROM NEW ZEALAND

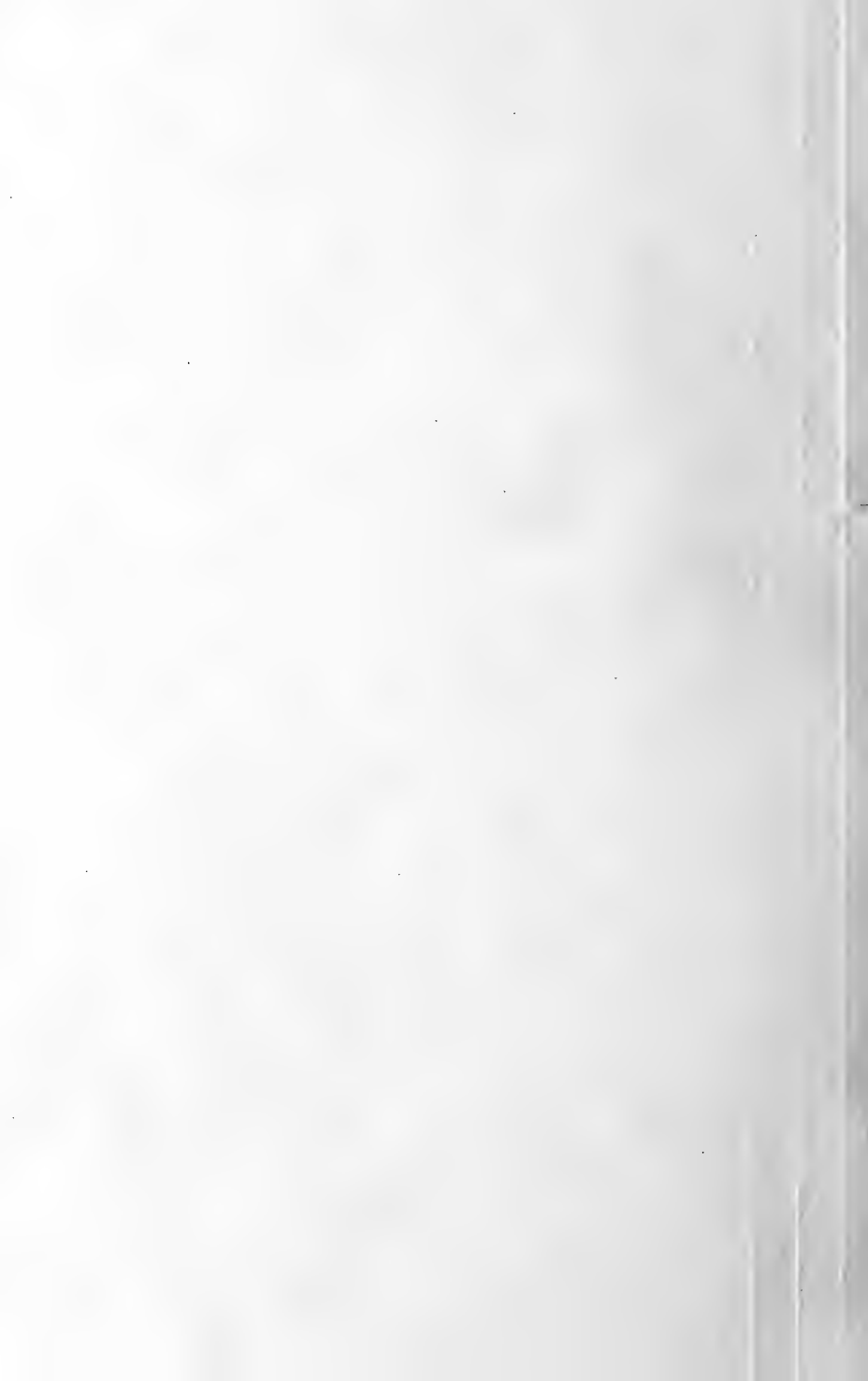
*Mus Linn. Brca. imp.*





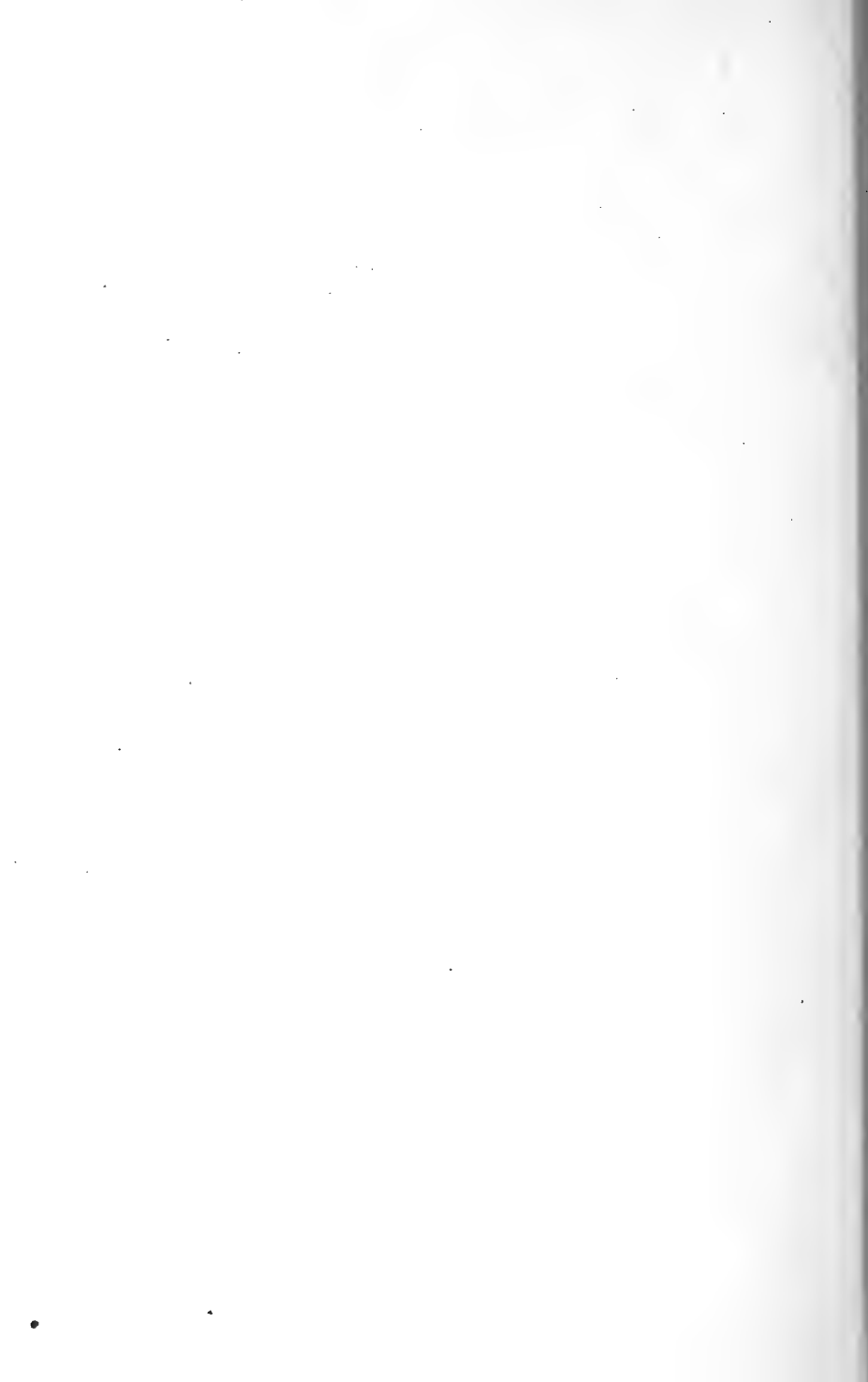


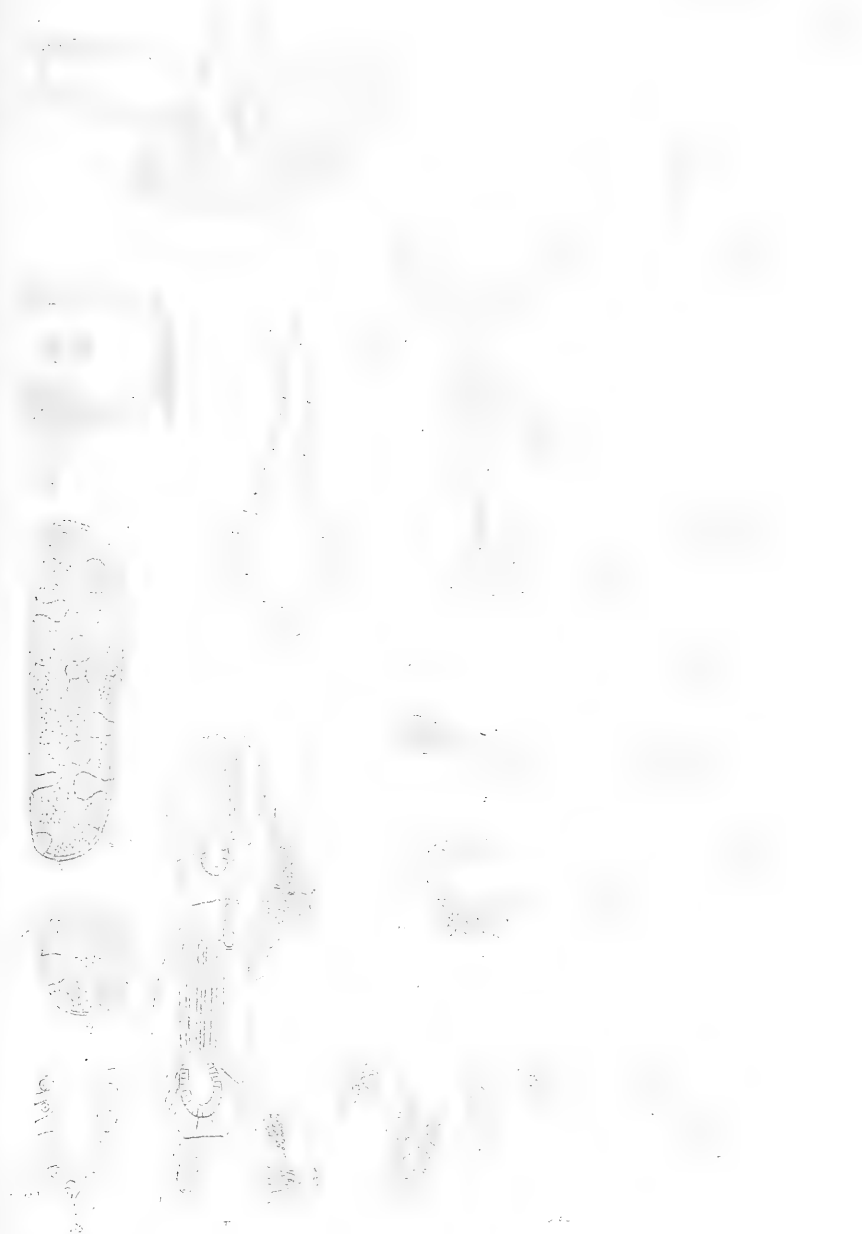








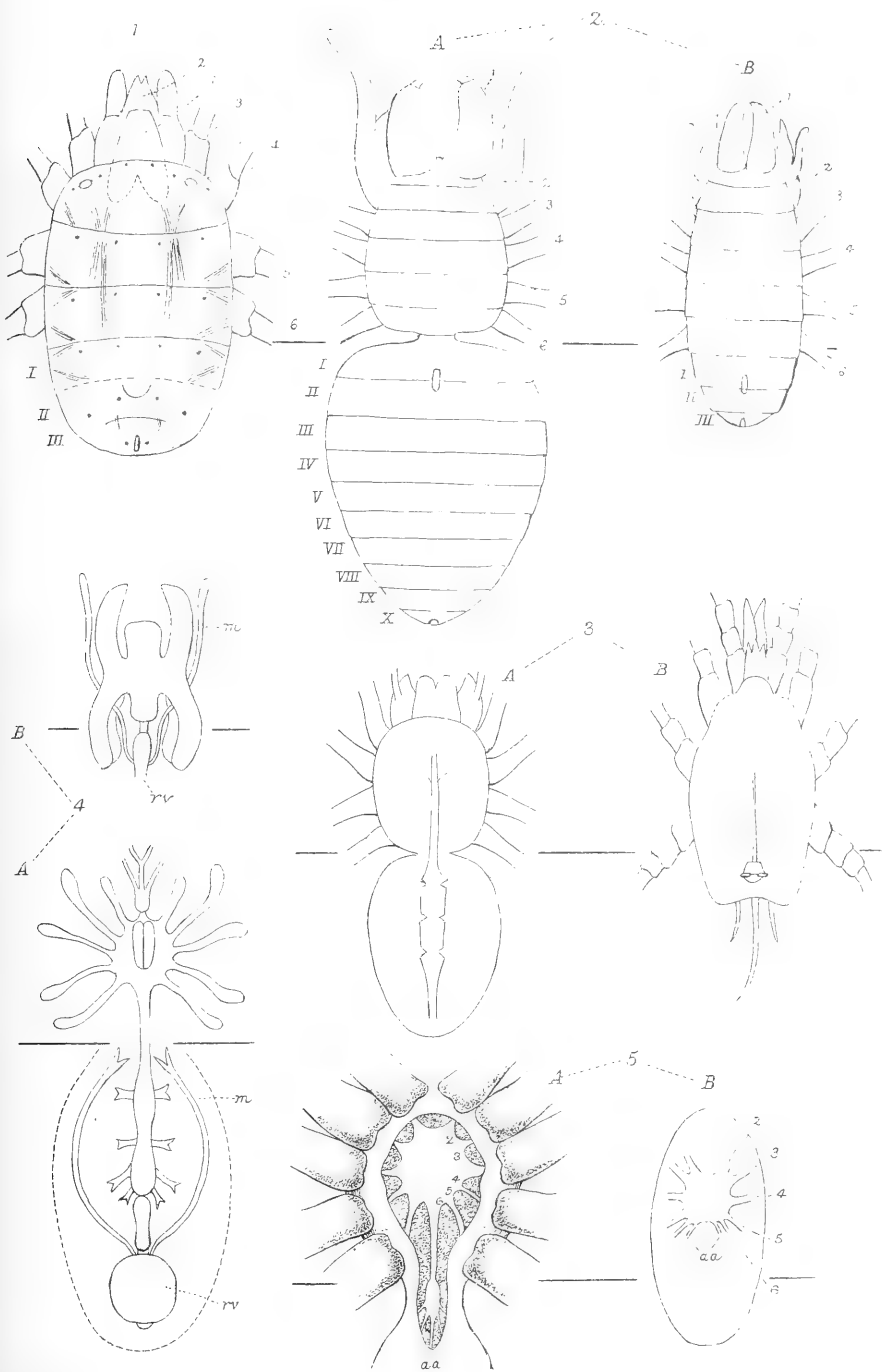




Am. Mus. Nat. Hist.  
 A. C. Howell, Jr.

West. Washington Univ.

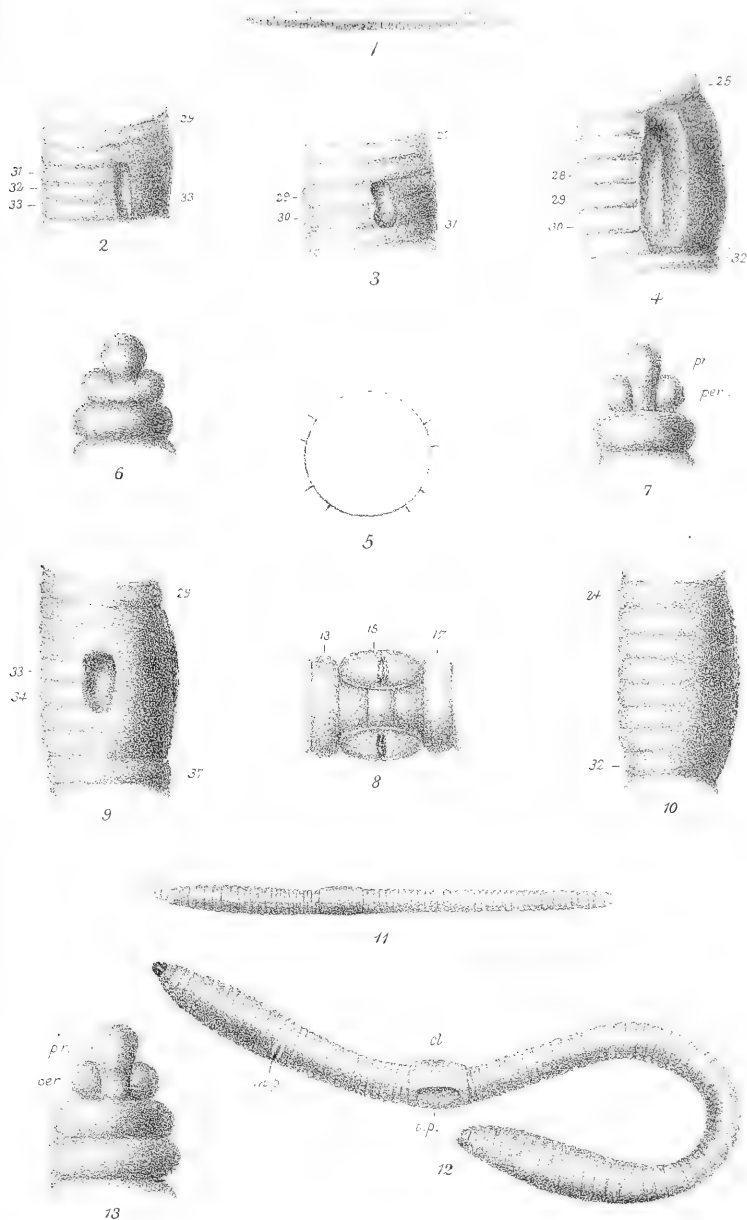




H. Bernard del.  
Berjeau & Highley lith.

West, Newman imp





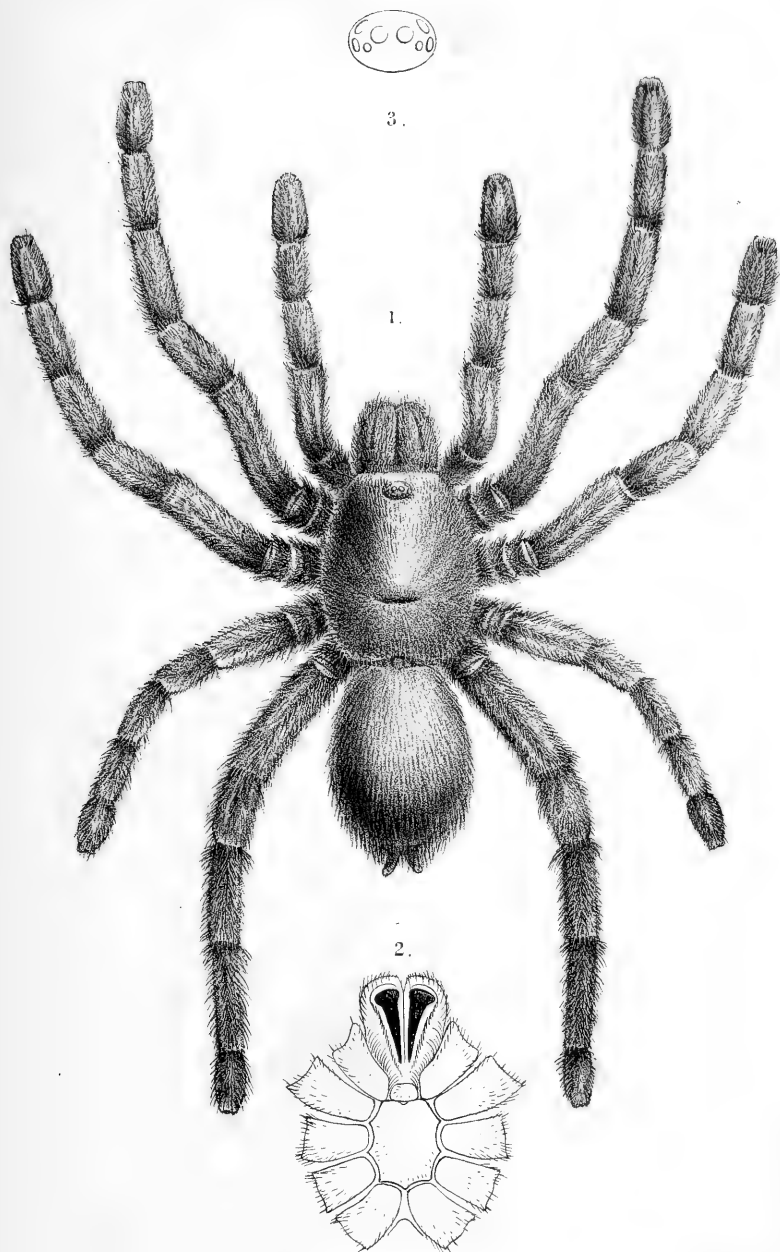
H.Friend del ad nat

Hambart lith.

A.R.Hammond lith







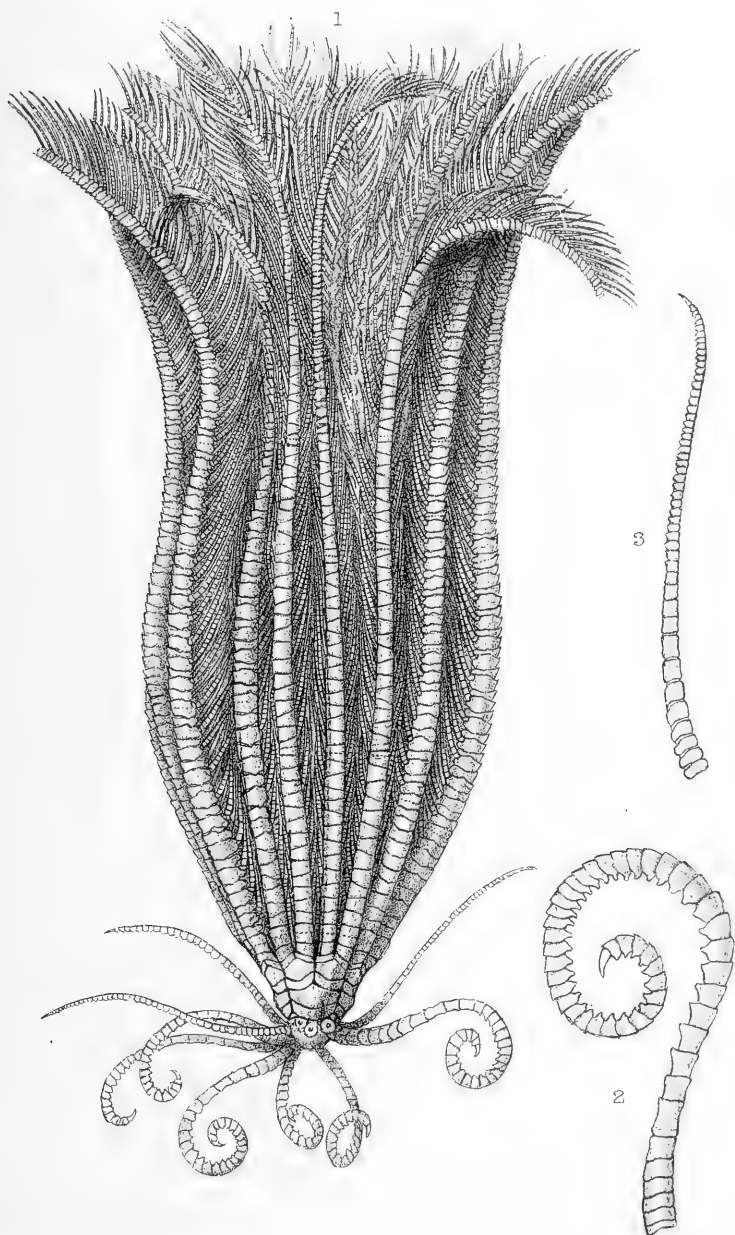
J. Green del. et lith.

Mintern Bros. imp.

ORNITHOCTONUS ANDERSONI, Pocock, (*Nat. size*).

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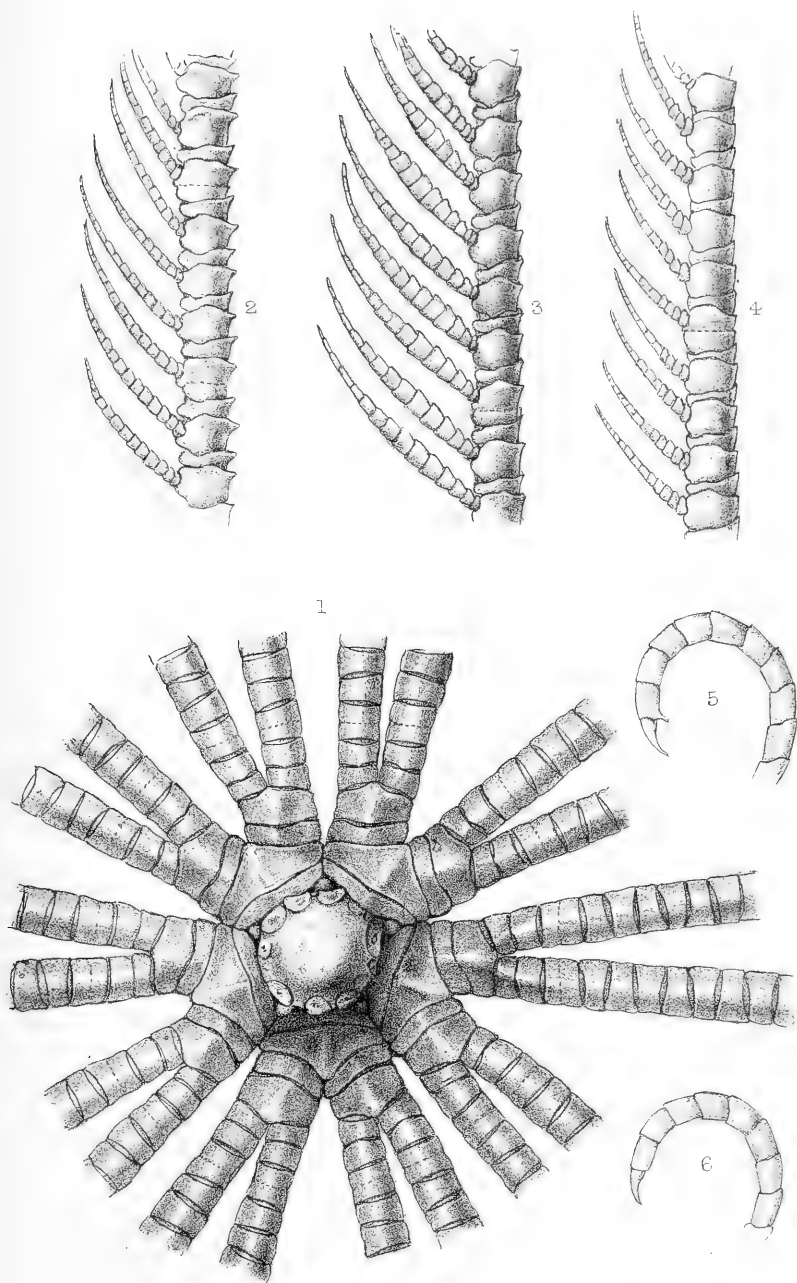


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West Newman imp.

ANTEDON WOOD-MASONI



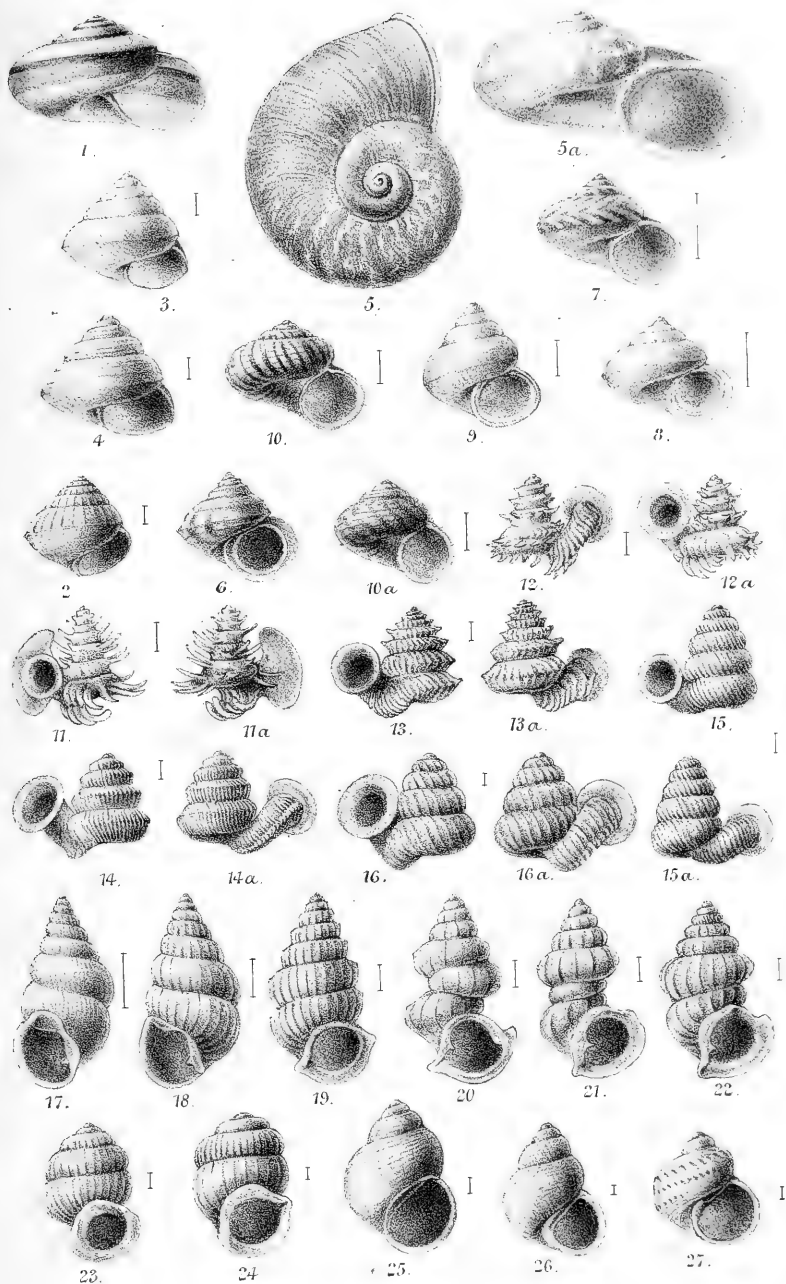


Berjeau & Highley del. et lith.

West Newman imp.

ANTEDON WOOD-MASONI & A. PATULA.

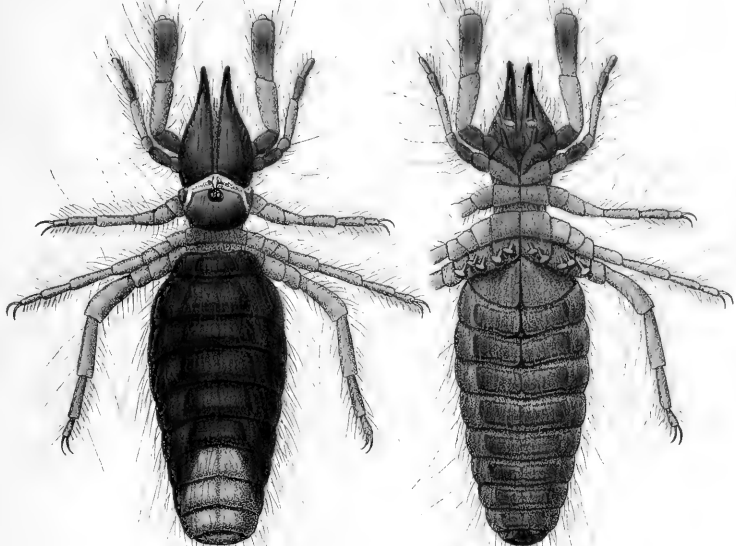




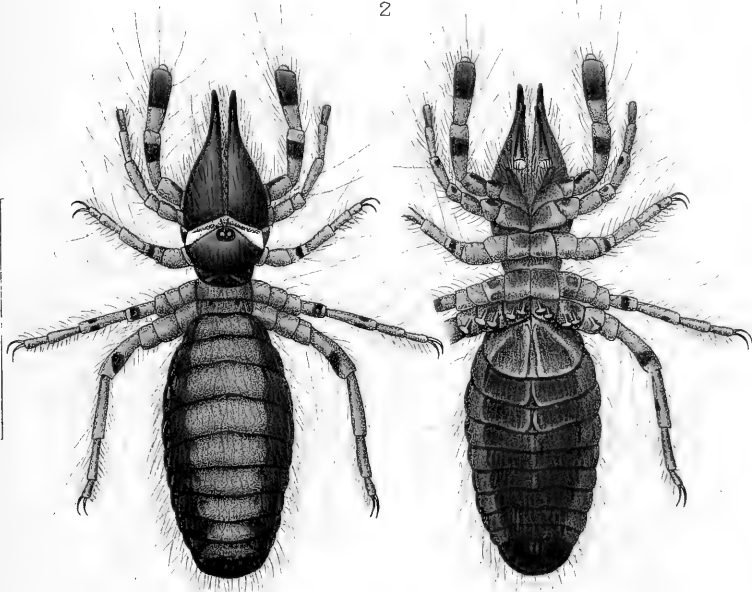




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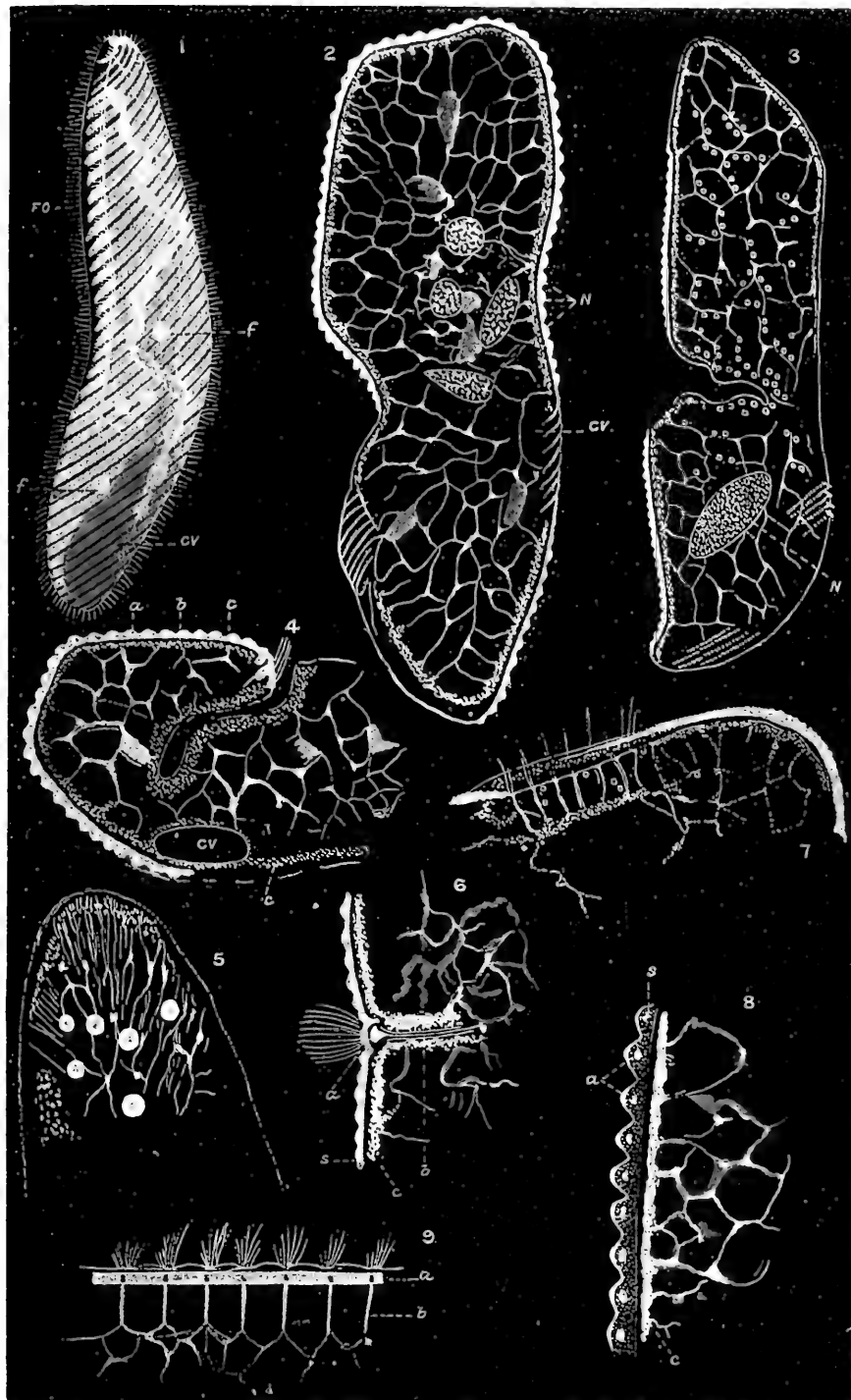


M.P. Parker del et lith.

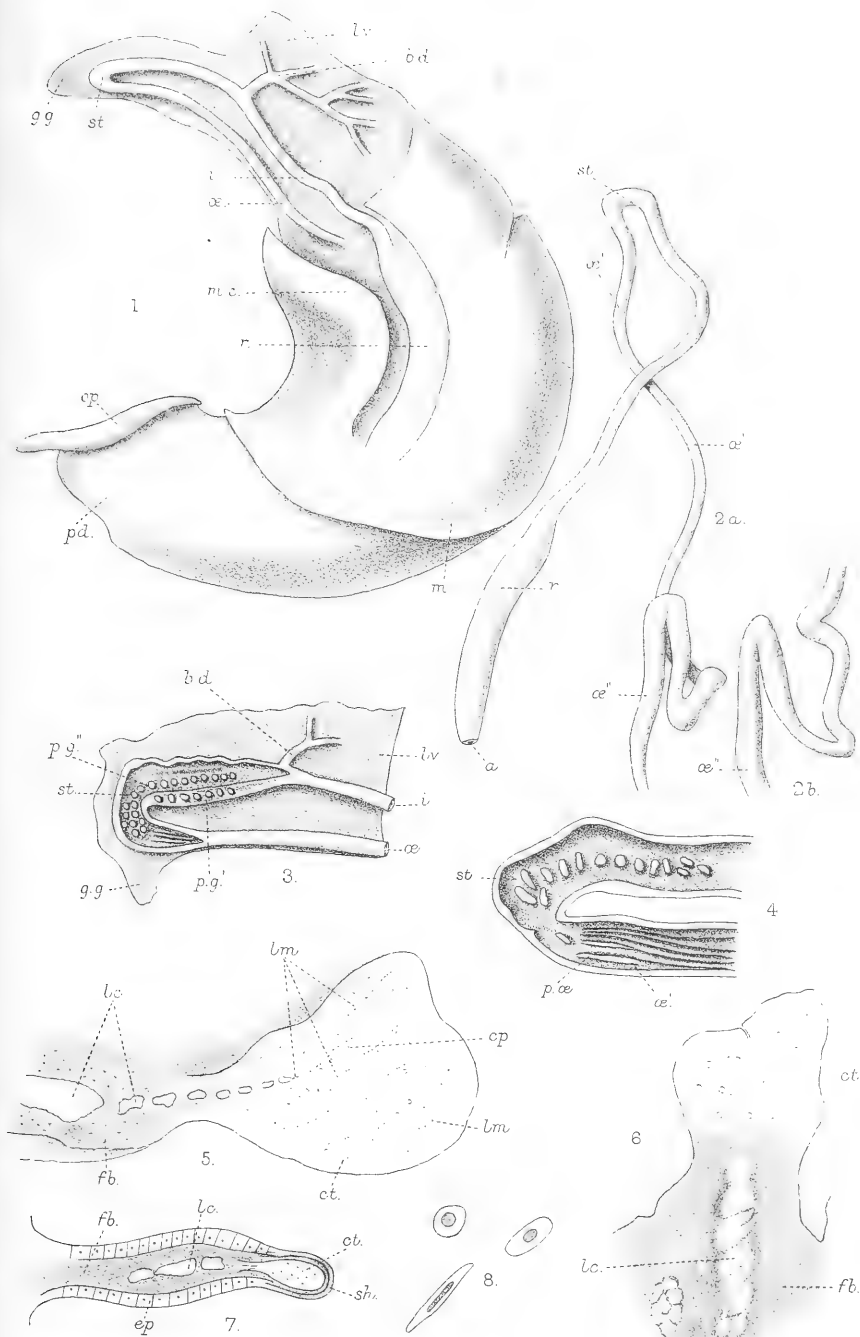
West, Newman imp.

1. RHAX HOWESII, n.sp. 2. RHAX NIGROCINCTA n.sp.

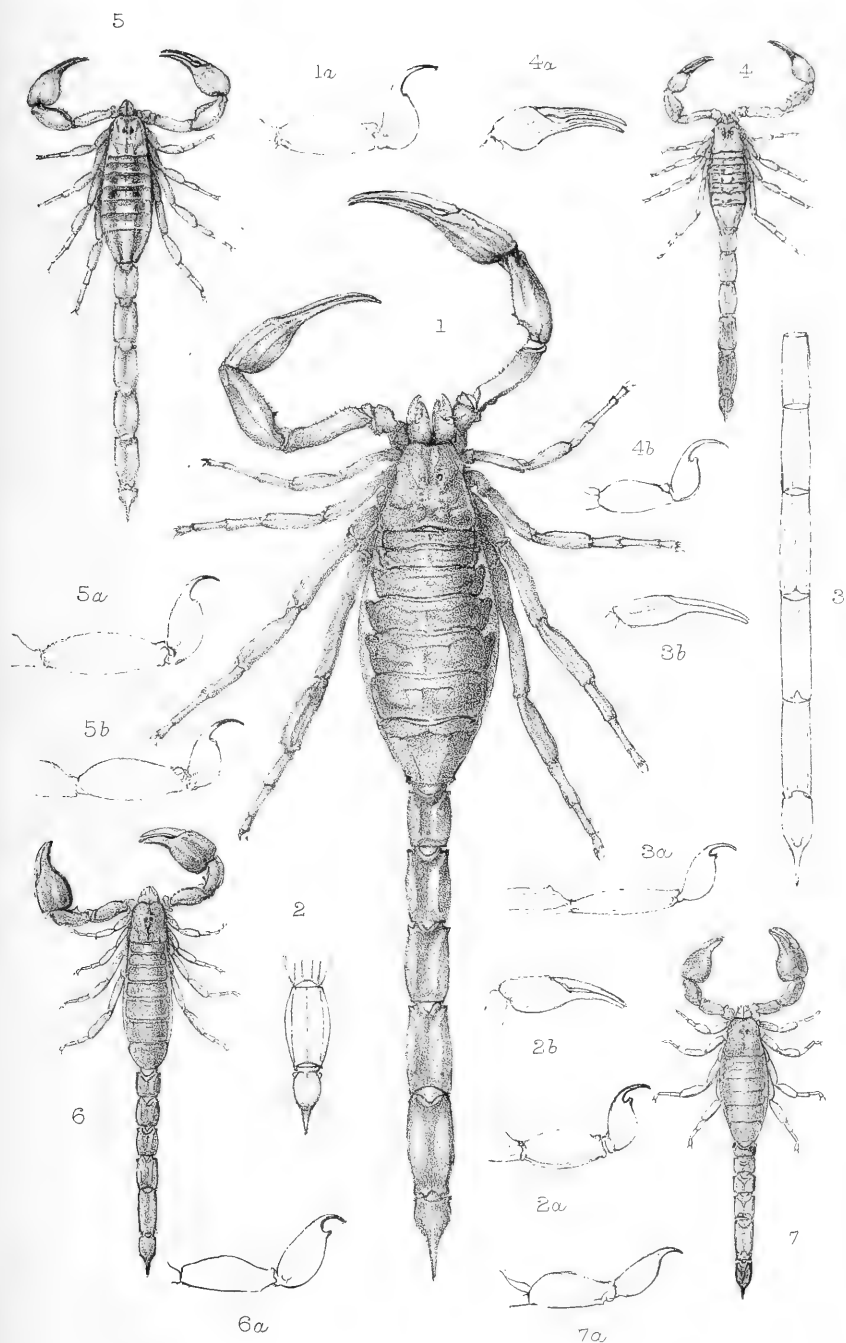












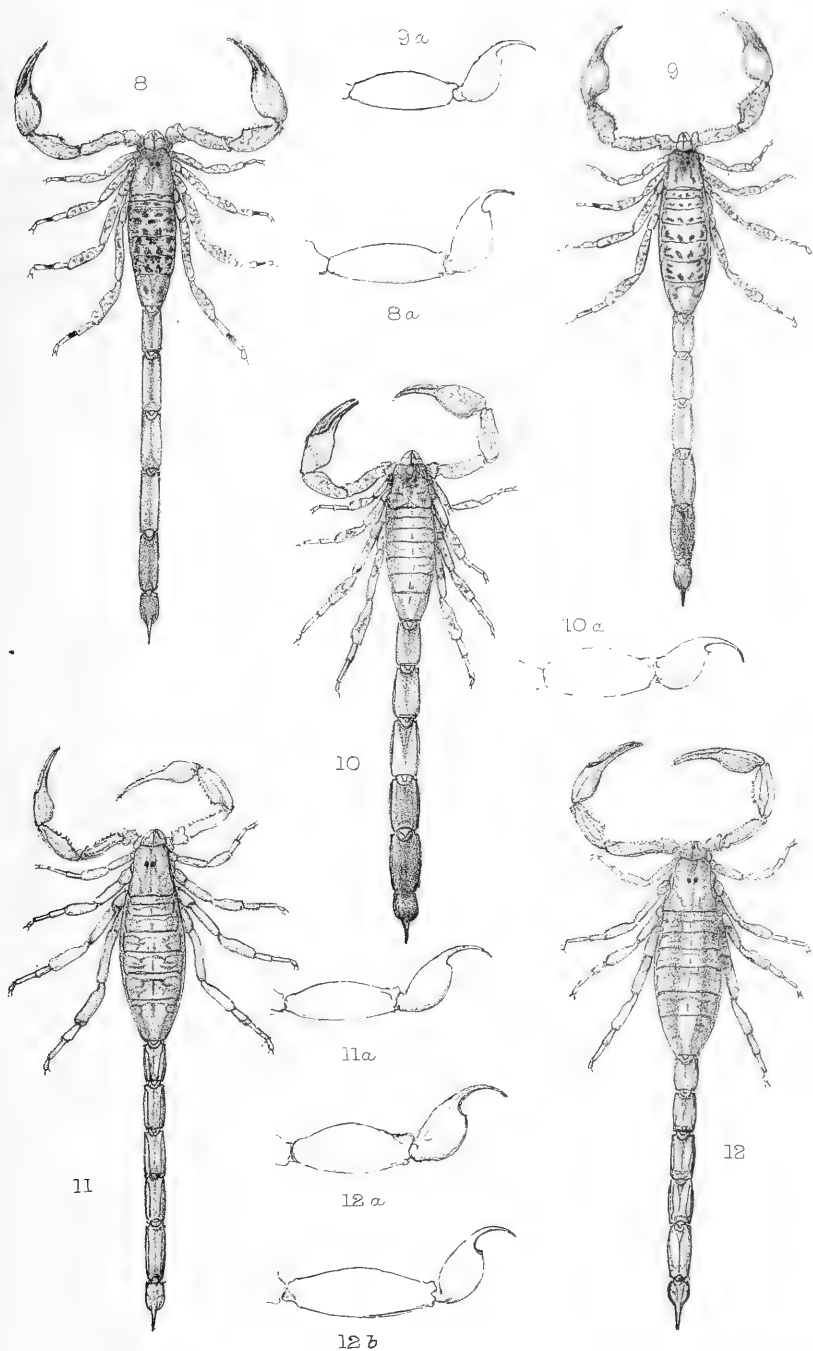
C. Berjeau, del. ad. nat.

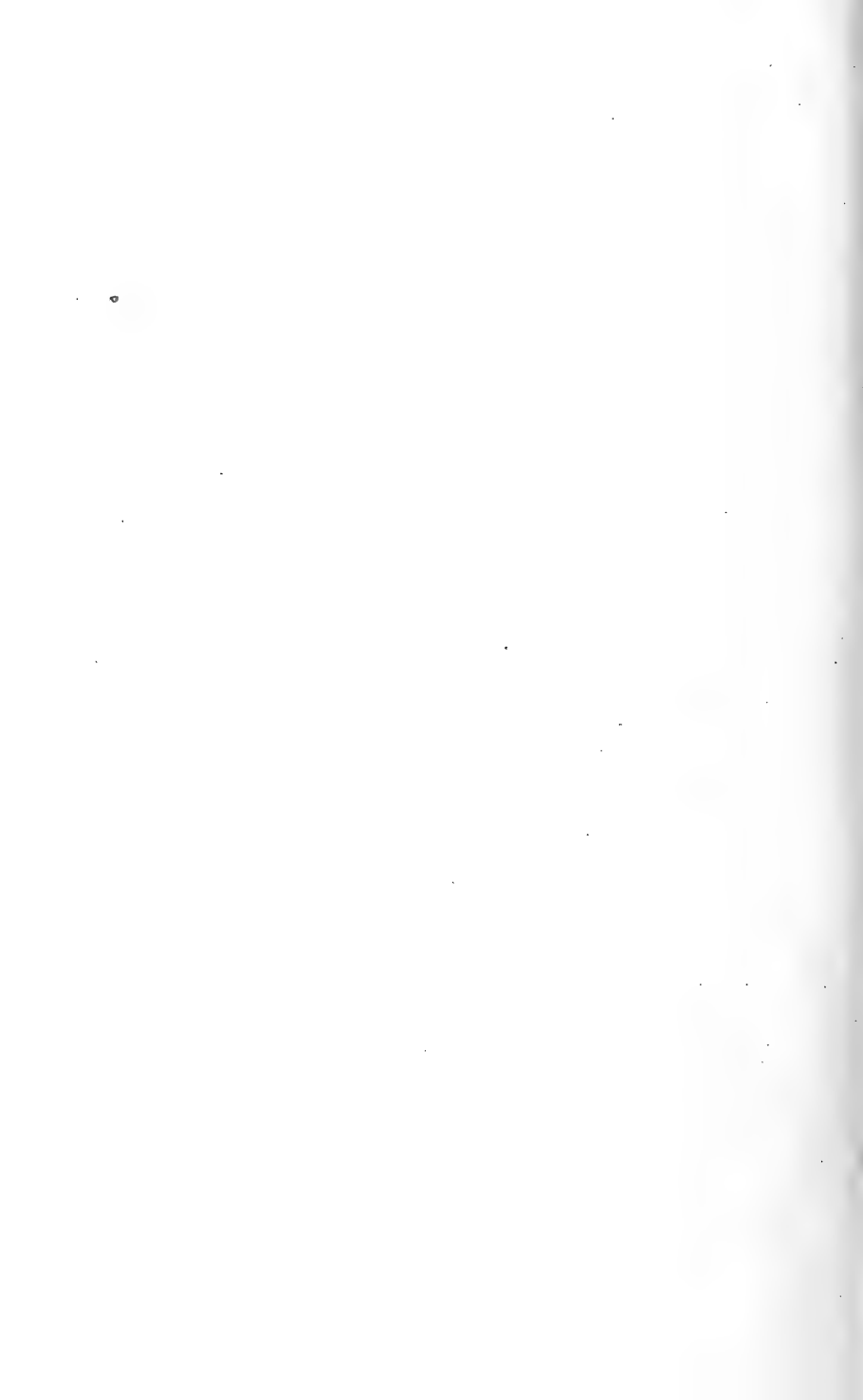
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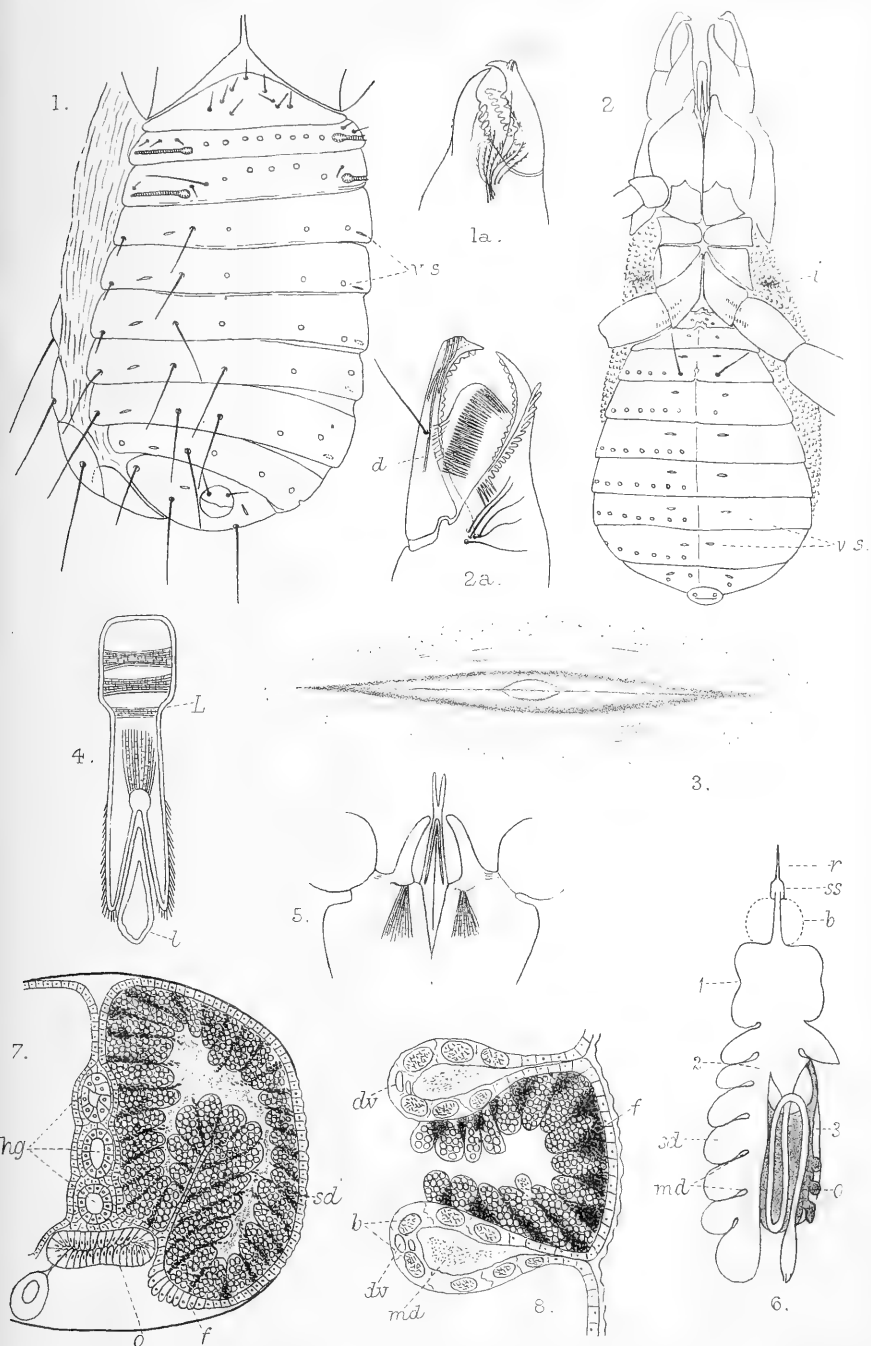
SCORPIONS FROM W. INDIES.









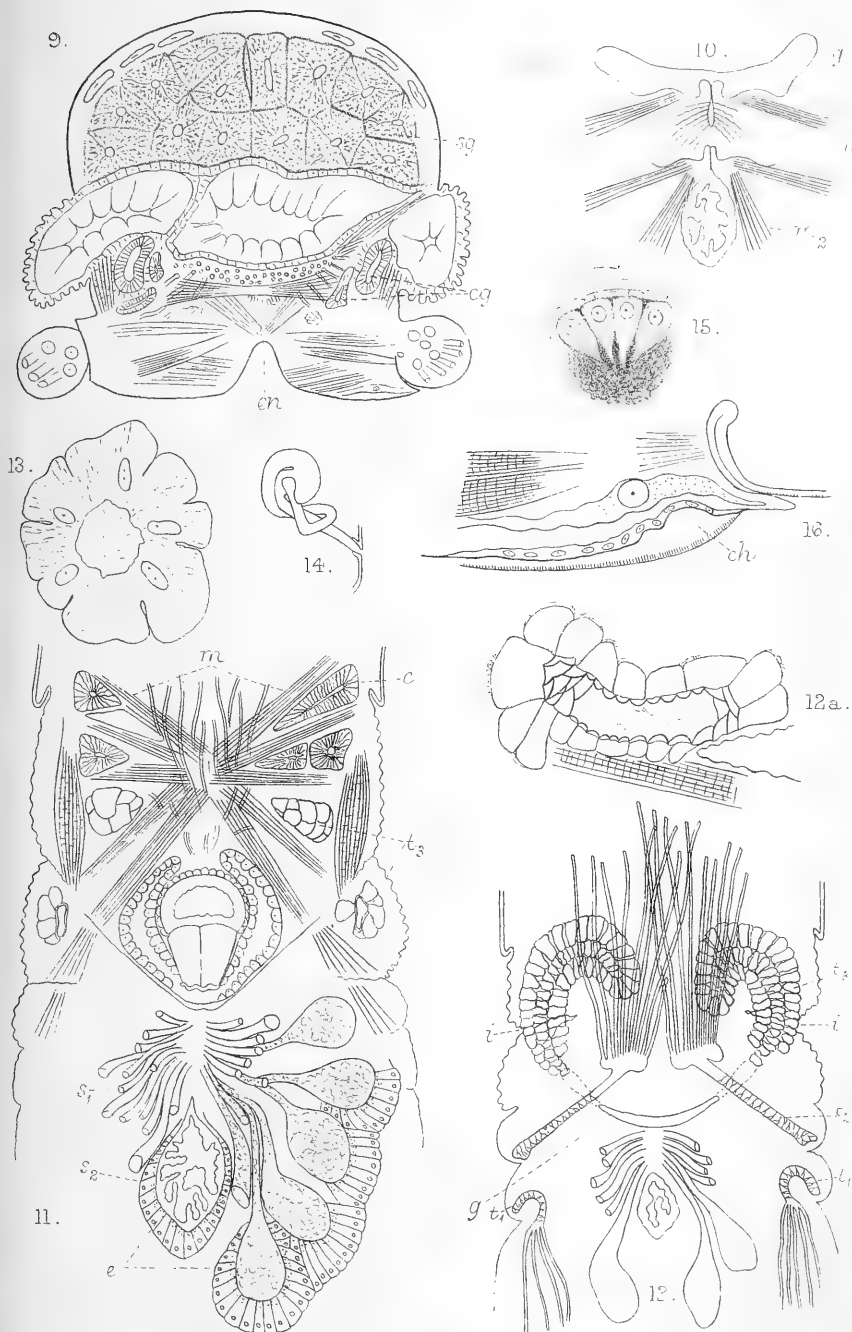


H.M. Bernard del. M.P. Parker lith.

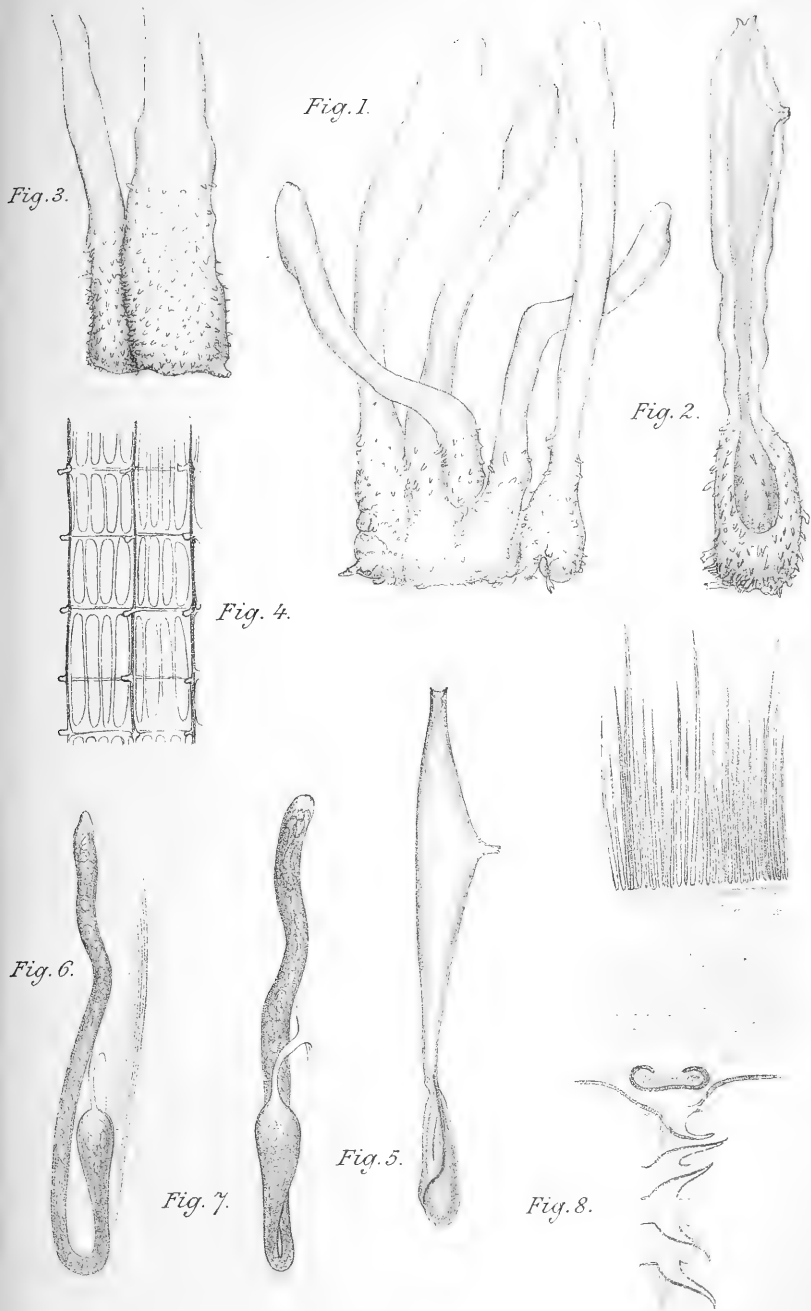
Mintern Bros. imp.

ANATOMY OF THE CHEIMNETIDÆ.









W.A. Herdman del.

F. Huth, Lith. Edin.

*CIONA FASCICULARIS*, Hancock.  
(from Dr Norman's types.)





Fig. 1.



Fig. 2.



Fig. 4.



Fig. 5.



Fig. 6.



Fig. 3.

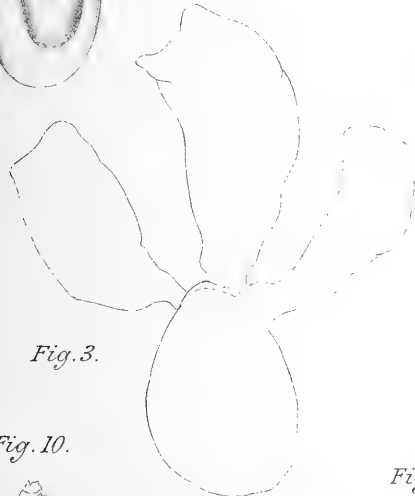


Fig. 10.



Fig. 9.

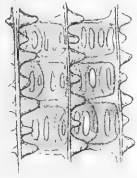


Fig. 8.

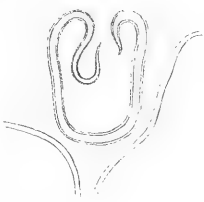


Fig. 7.



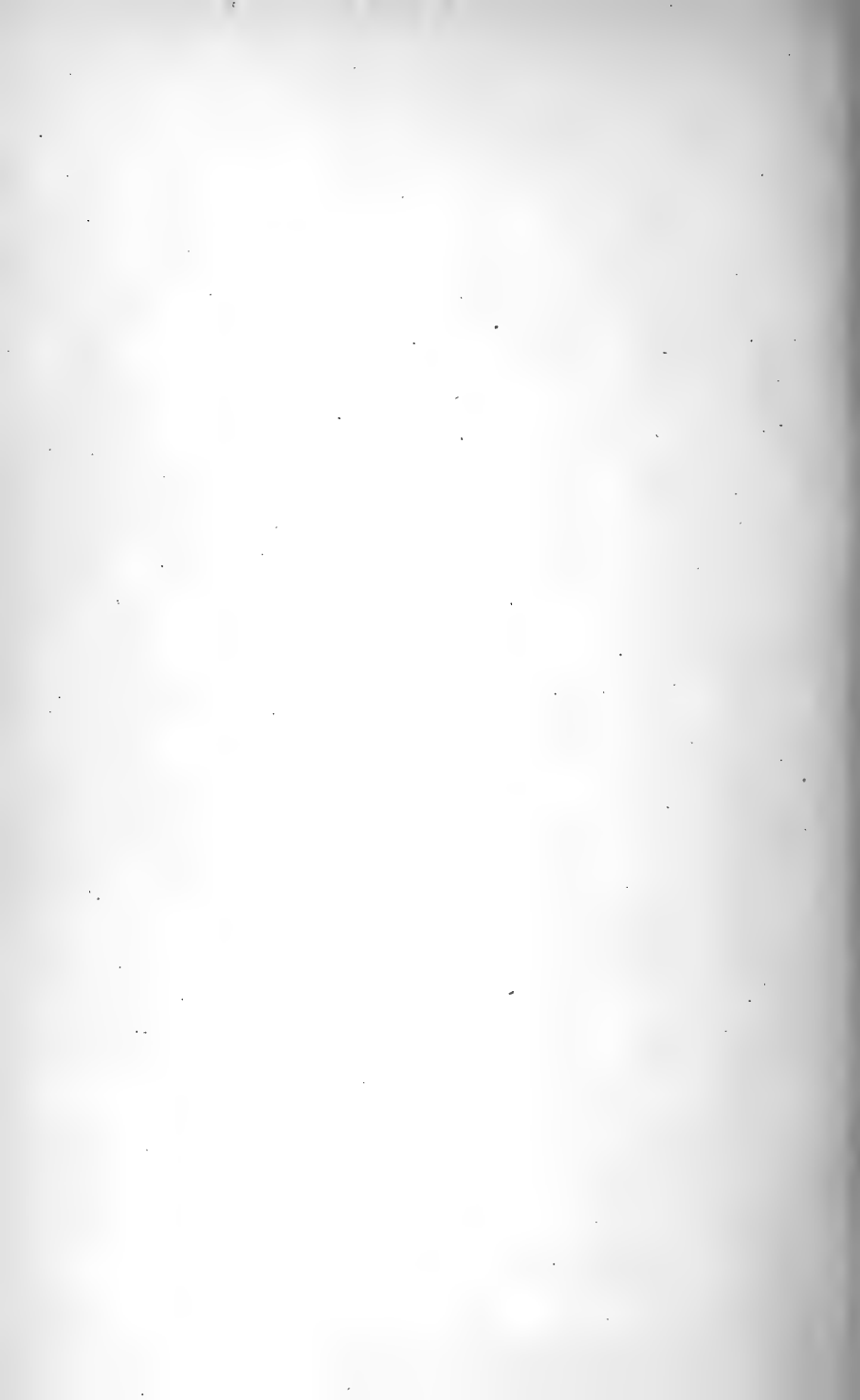


Fig. 1.

Fig. 2.

Fig. 4.

Fig. 3.

Fig. 7.

Fig. 9.

Fig. 10.

Fig. 8.

Fig. 5.

Fig. 6.

Fig. 11.

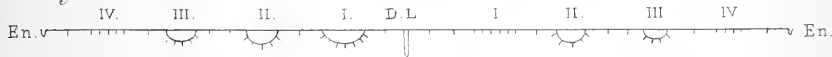
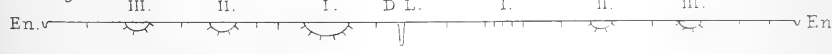


Fig. 12.



Fig. 13.



Right side.

Left side.



Fig. 1.



Fig. 9.



Fig. 2.



Fig. 10.

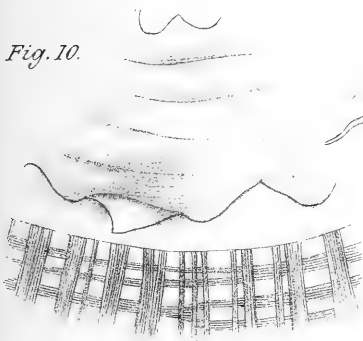


Fig. 8.

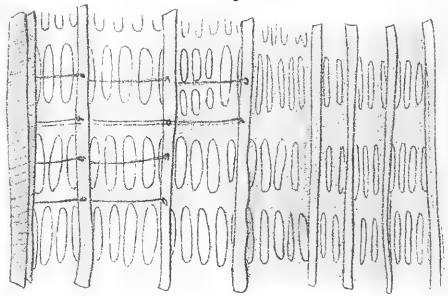


Fig. 3.



Fig. 4.



Fig. 5.

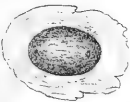


Fig. 6.



Fig. 7.



Fig. 11.

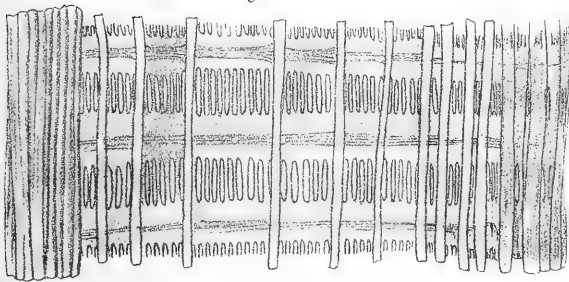
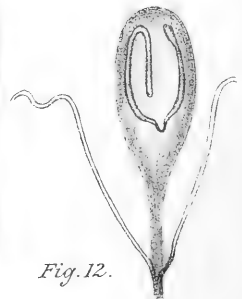


Fig. 12.

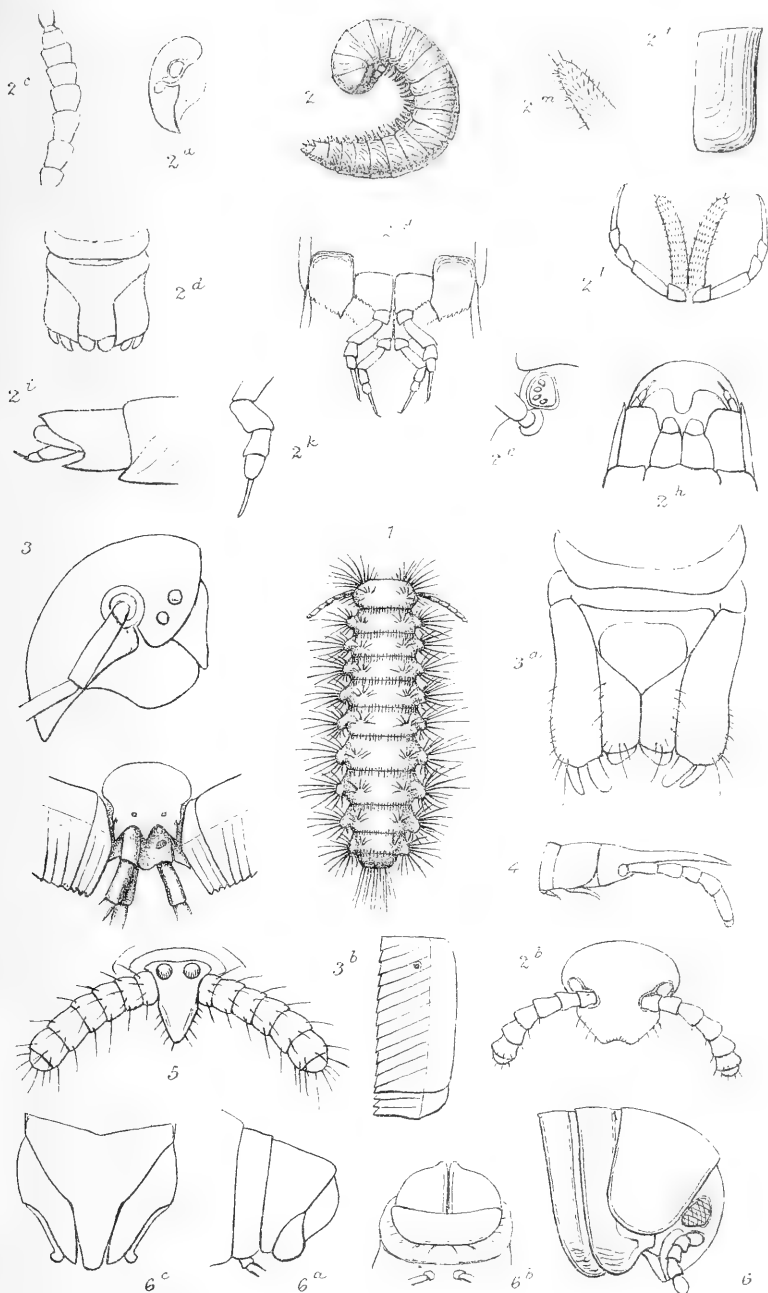


W.A. Herdman del.

F. Huth, Lith. Edin.

Fig. 1, *STYELA RUSTICA*. Fig. 2, *STYELA MONOCEROS*.  
 Figs 3-10, *FORBESELLA TESSELLATA*. Figs 11, 12, *POLYCARPA QUADRANGULARIS*.





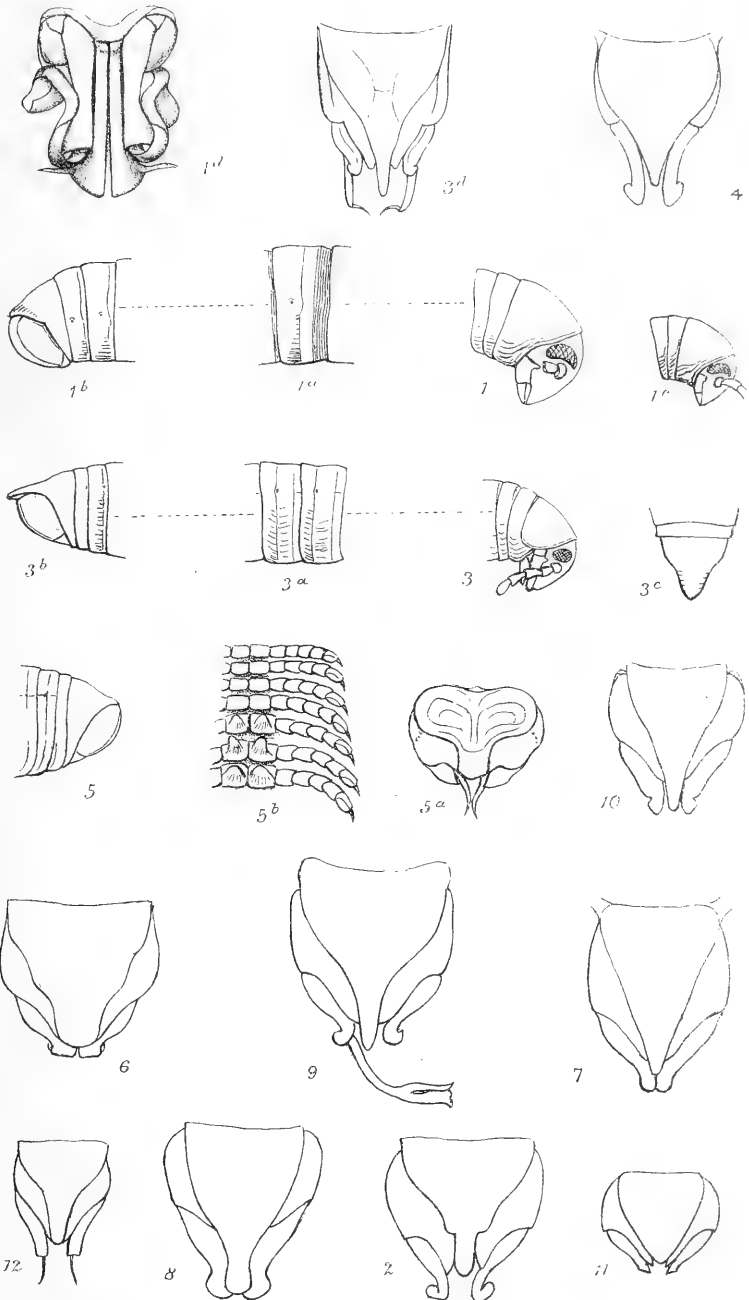
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West, Newman. imp.

DIPLOPODA FROM WEST INDIES.





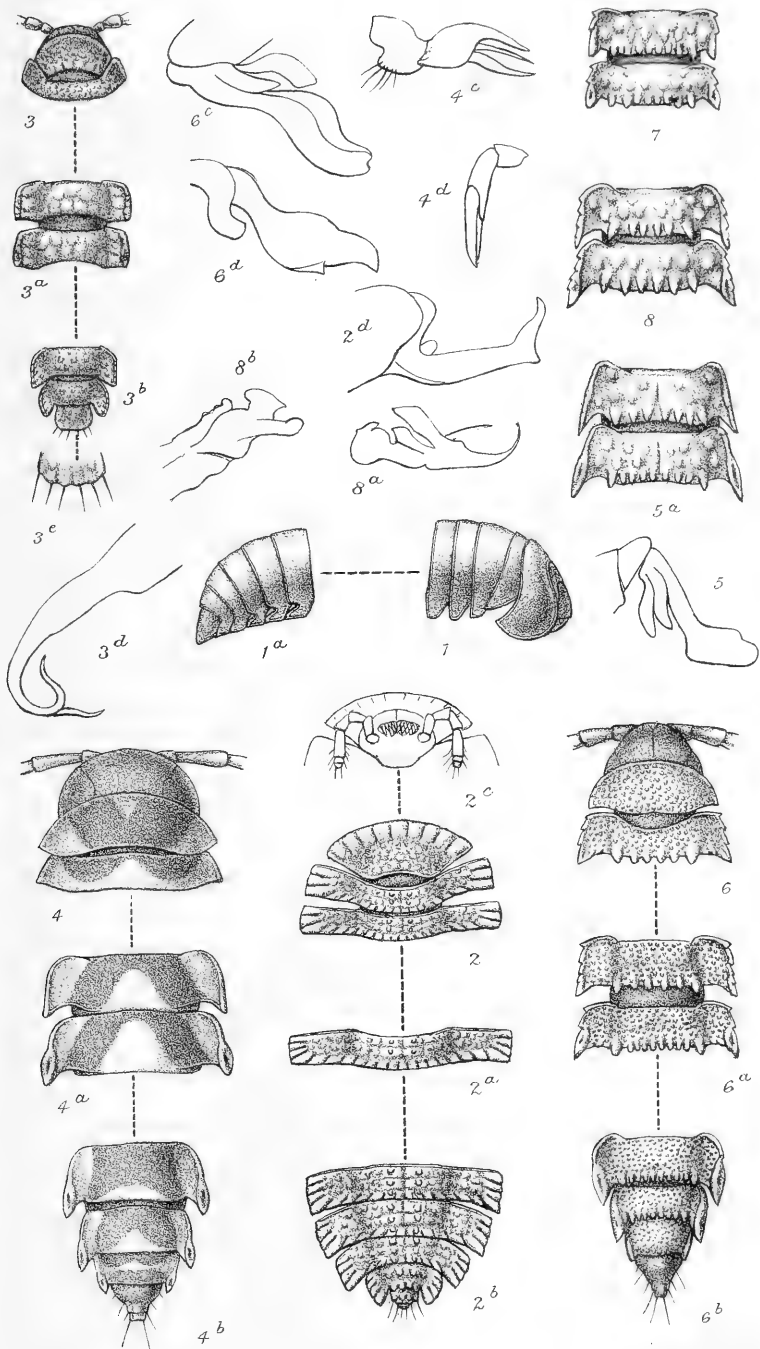


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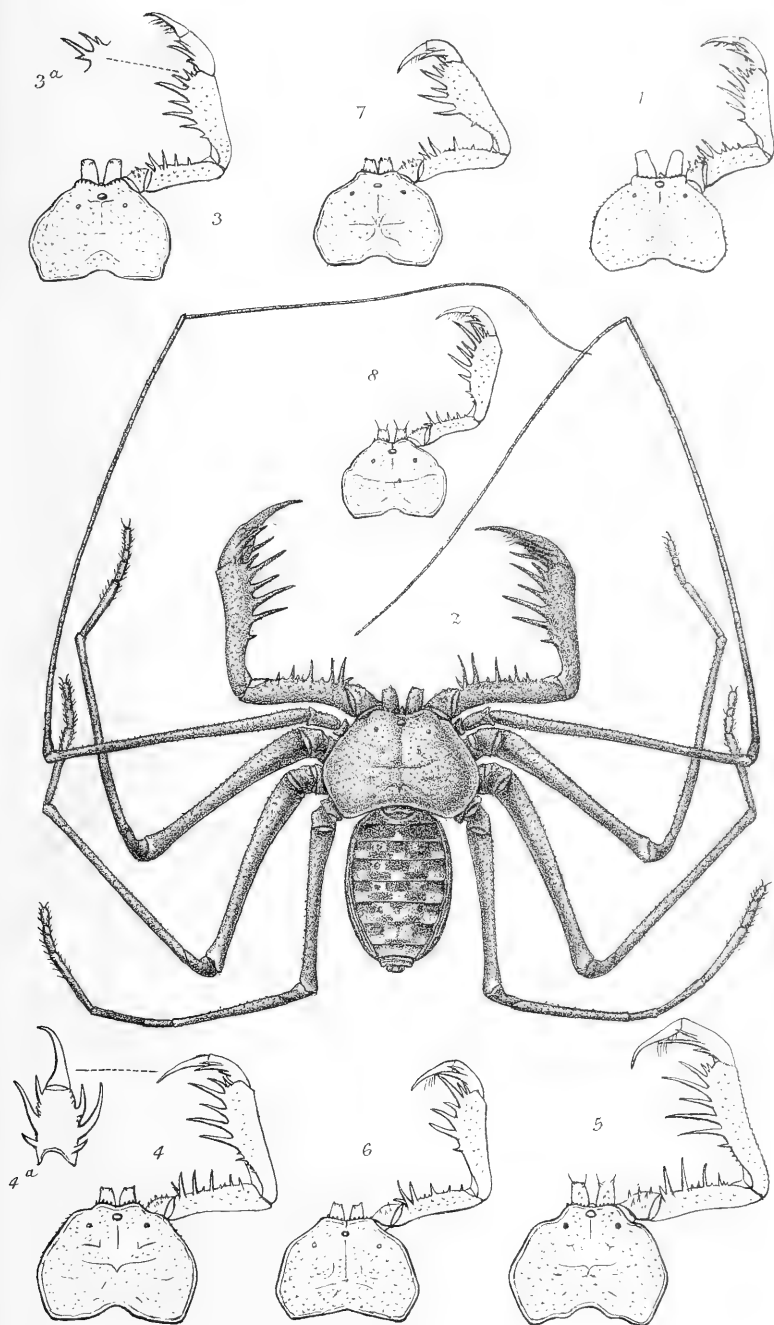




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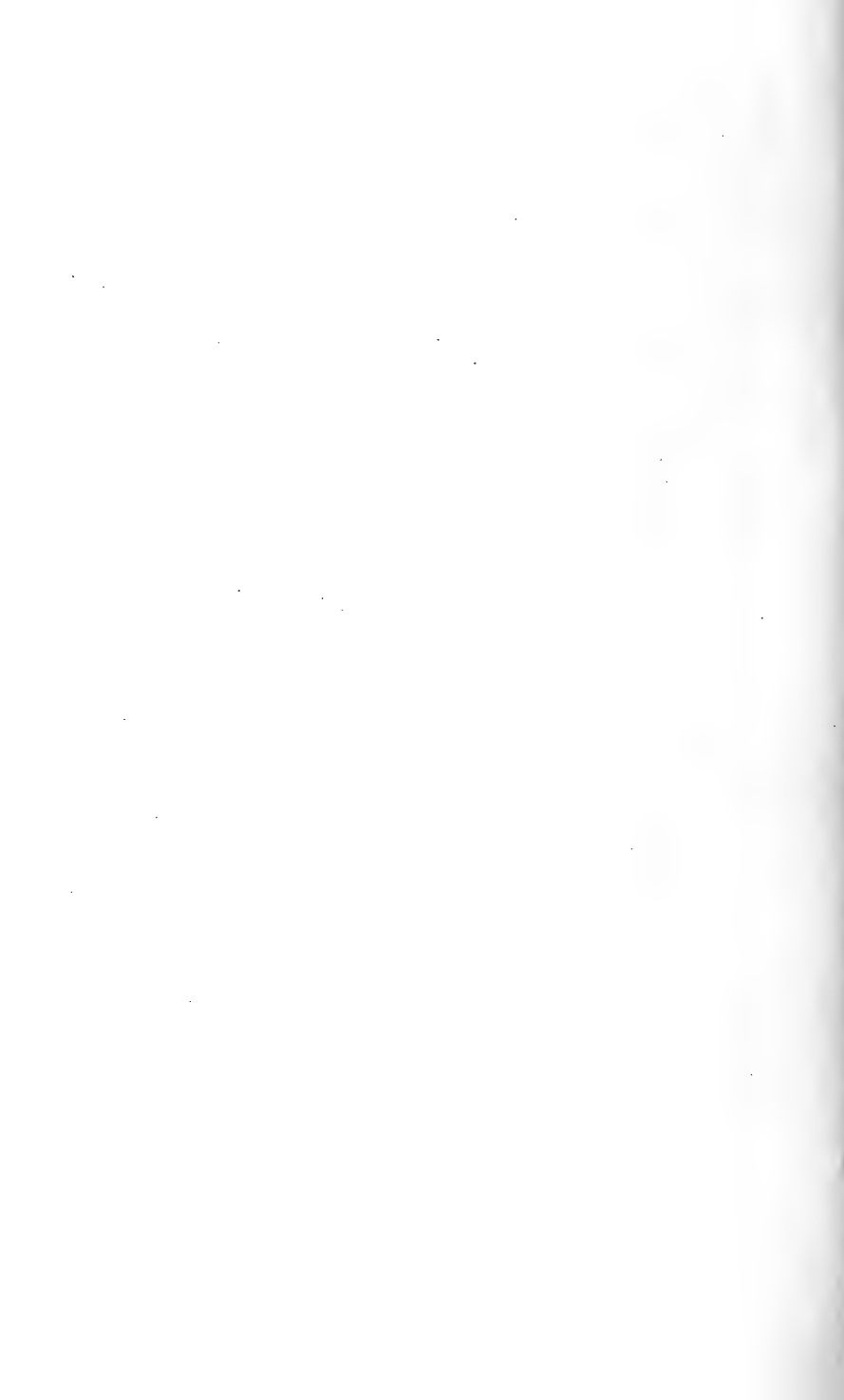


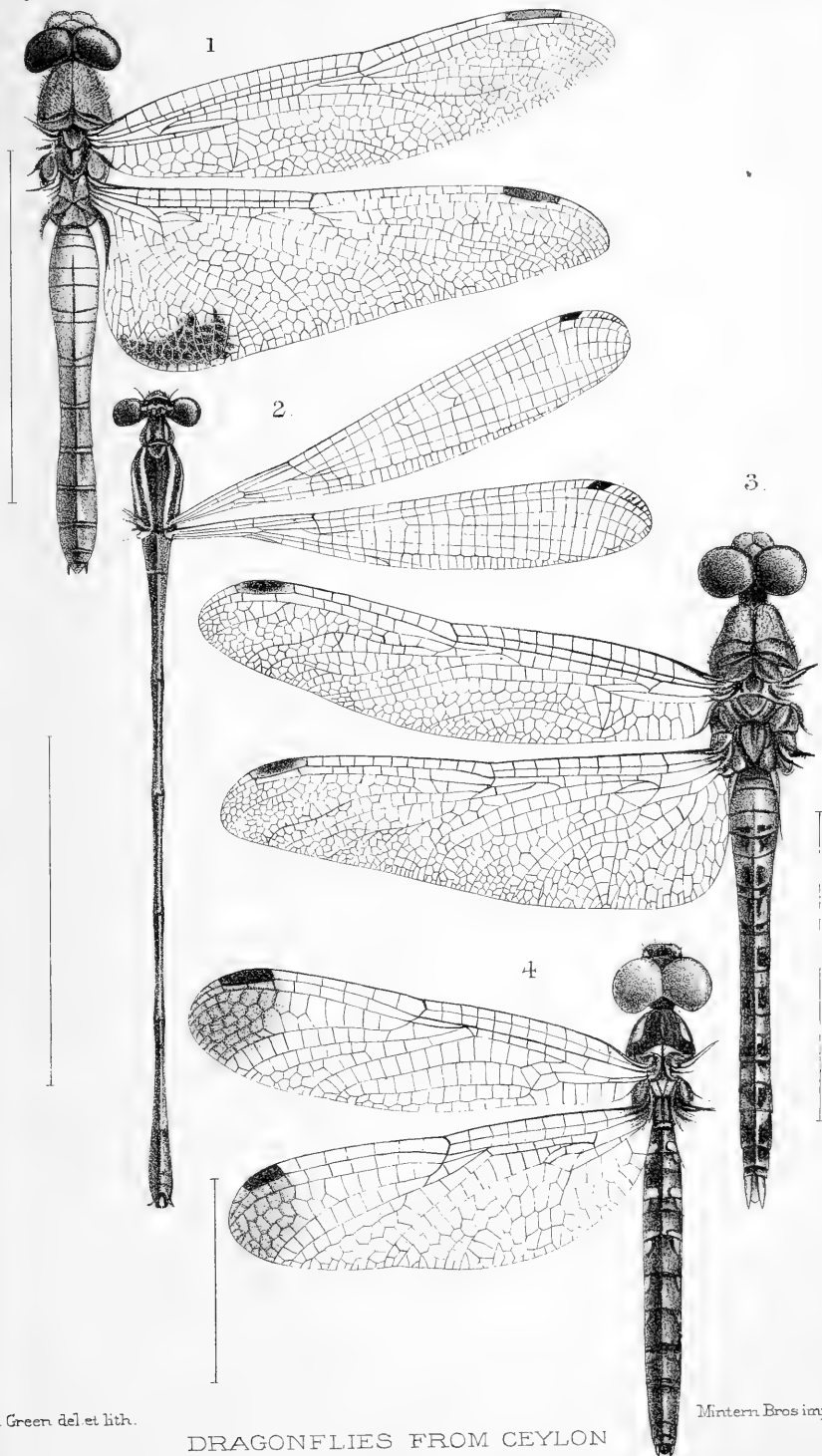


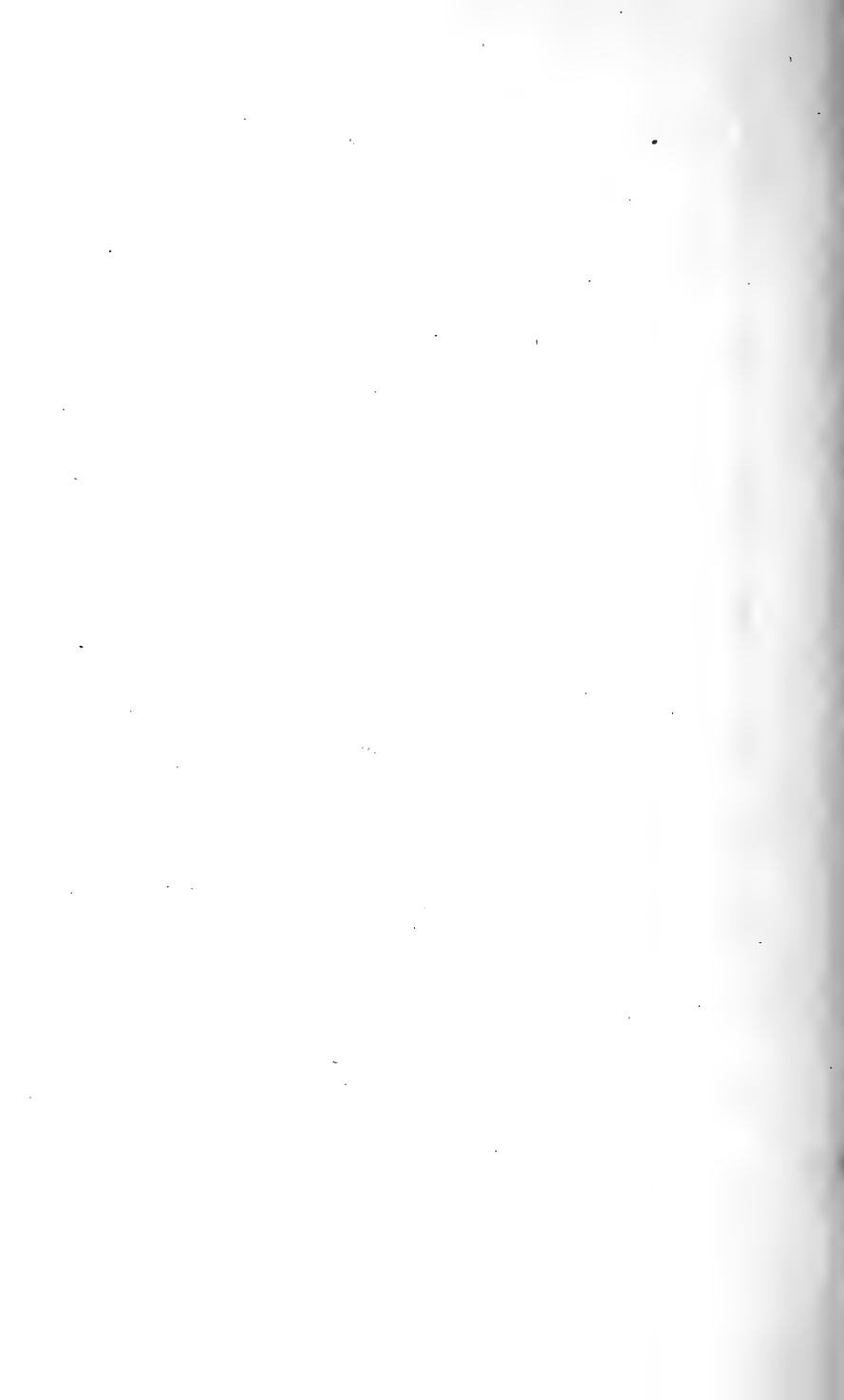
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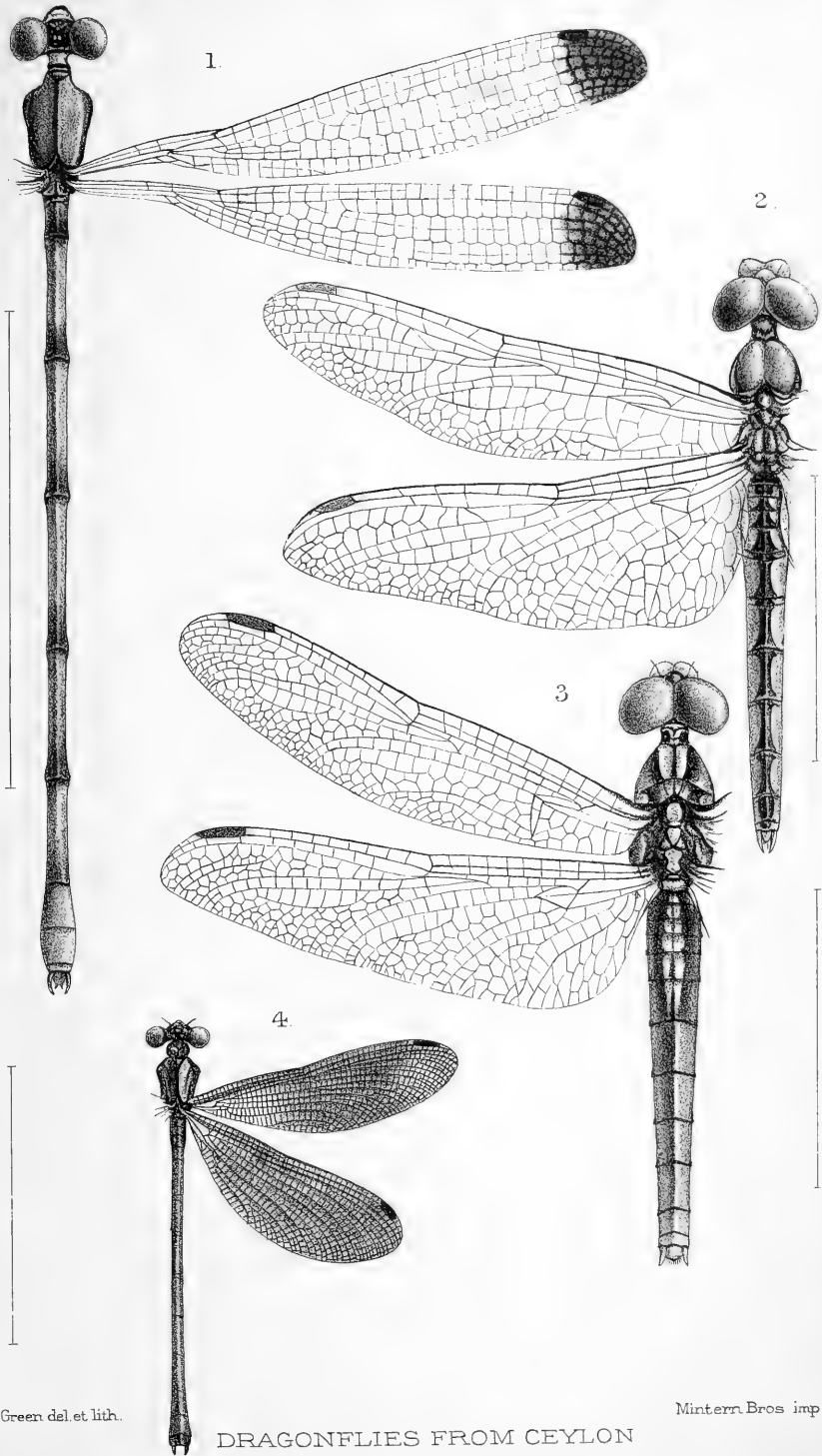
PEDIPALPI FROM WEST INDIES.







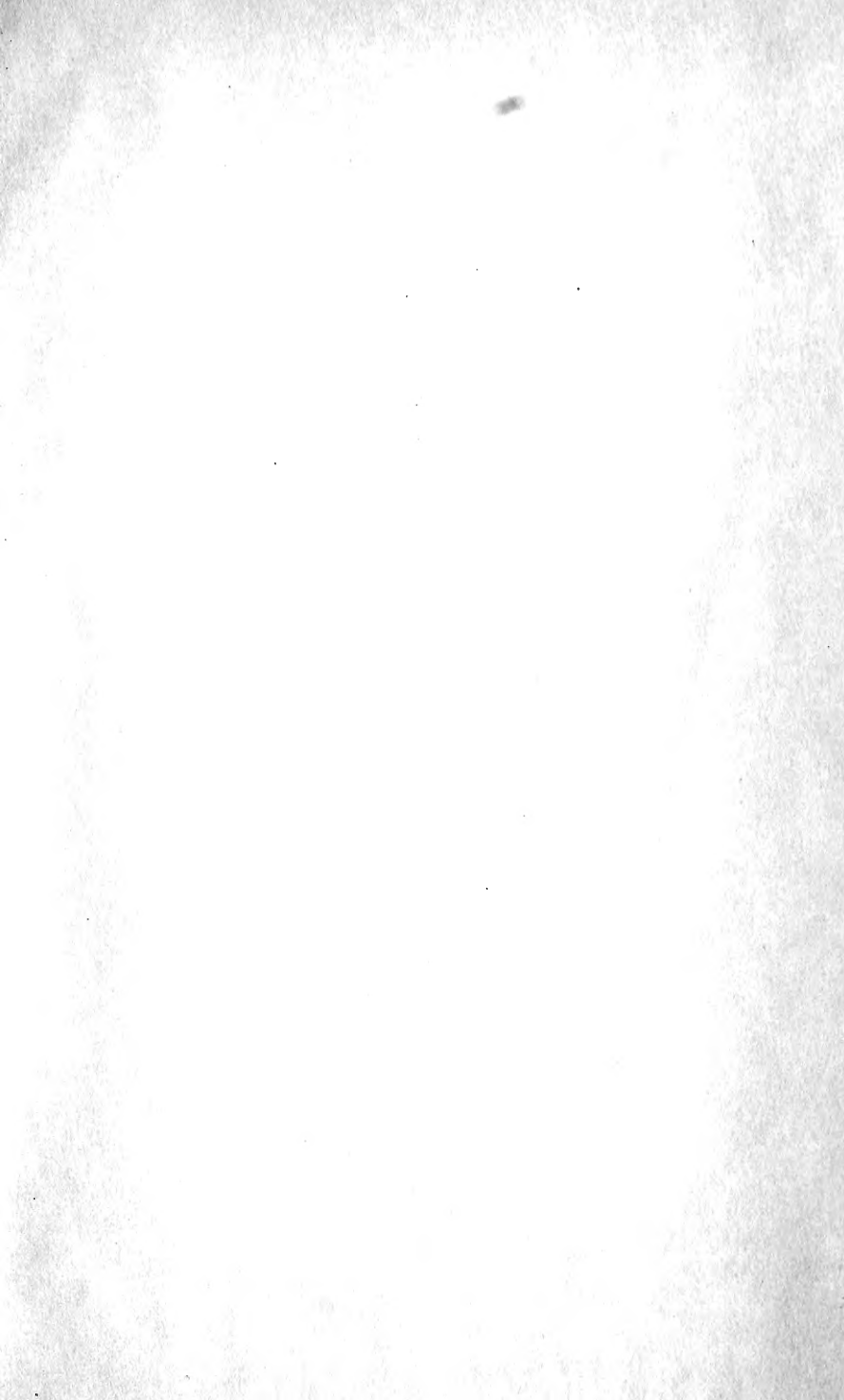




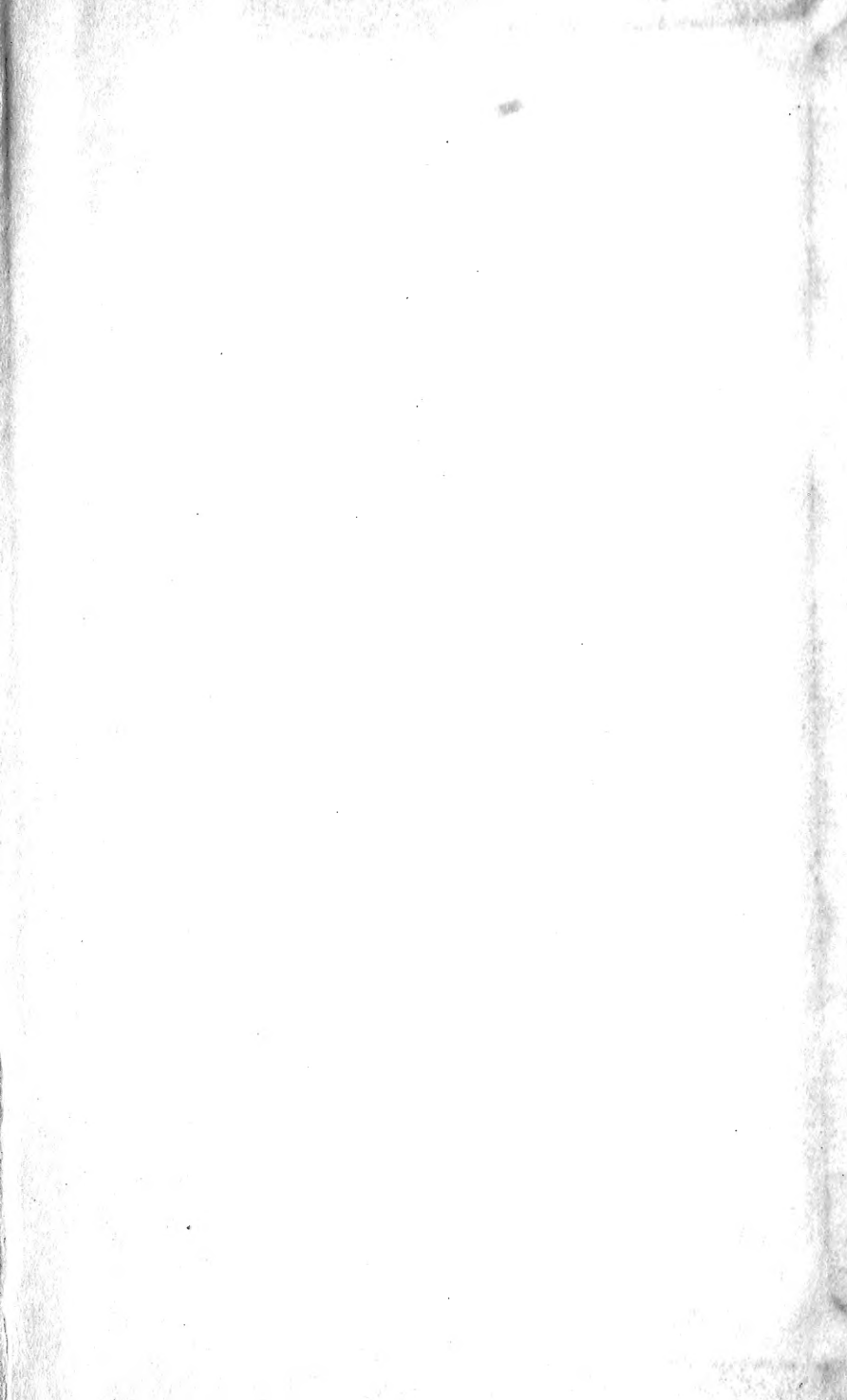












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